Final

Atlantic Fleet Active Sonar Training Environmental Impact Statement/ Overseas Environmental Impact Statement

Lead Agency:
Department of the Navy

Action Proponent:
United States Fleet Forces Command

For Additional Information:
Naval Facilities Engineering Command, Atlantic
Attention: Code EV22 (Atlantic Fleet Sonar Project Manager)
6506 Hampton Boulevard
Norfolk, VA 23508-1278
http://afasteis.gcsaic.com

Cooperating Agency:
Office of Protected Resources
National Marine Fisheries Service
1315 East-West Highway
Silver Spring, Maryland 20910-3226

Published December 12, 2008

Abstract:

The Department of the Navy has prepared this Environmental Impact Statement/Overseas Environmental Impact Statement to analyze the potential environmental effects associated with the use of active sonar technology and the improved extended echo ranging system during Atlantic Fleet training exercises, maintenance, and research, development, test, and evaluation activities. The potential effects to physical, biological, and man-made environmental resources associated with the training alternatives were studied to determine how the Proposed Action could affect these resources.

Final

Atlantic Fleet Active Sonar Training Environmental Impact Statement/ Overseas Environmental Impact Statement

Lead Agency:
Department of the Navy

Action Proponent:
United States Fleet Forces Command

For Additional Information:
Naval Facilities Engineering Command, Atlantic
Attention: Code EV22 (Atlantic Fleet Sonar Project Manager)
6506 Hampton Boulevard
Norfolk, VA 23508-1278
http://afasteis.gcsaic.com

Cooperating Agency:
Office of Protected Resources
National Marine Fisheries Service
1315 East-West Highway
Silver Spring, Maryland 20910-3226

Published December 12, 2008

Abstract:

The Department of the Navy has prepared this Environmental Impact Statement/Overseas Environmental Impact Statement to analyze the potential environmental effects associated with the use of active sonar technology and the improved extended echo ranging system during Atlantic Fleet training exercises, maintenance, and research, development, test, and evaluation activities. The potential effects to physical, biological, and man-made environmental resources associated with the training alternatives were studied to determine how the Proposed Action could affect these resources.

PRINTED ON RECYCLED PAPER

TABLE OF CONTENTS

Page

TABLE OF CONTENTS CONT'D

Page

TABLE OF CONTENTS CONT'D

Page

TABLE OF CONTENTS CONT'D

Page

TABLE OF CONTENTS CONT'D

Page

TABLE OF CONTENTS CONT'D

Page

TABLE OF CONTENTS CONT'D

Page

TABLE OF CONTENTS CONT'D

Page

TABLE OF CONTENTS CONT'D

Page

TABLE OF CONTENTS CONT'D

Page

TABLE OF CONTENTS CONT'D

Page

TABLE OF CONTENTS CONT'D

Page

TABLE OF CONTENTS CONT'D

Page

TABLE OF CONTENTS CONT'D

Page

TABLE OF CONTENTS CONT'D

Page

TABLE OF CONTENTS CONT'D

Page

TABLE OF CONTENTS CONT'D

Page

This page is intentionally blank.

LIST OF TABLES

Page

LIST OF TABLES CONT'D

Page

LIST OF TABLES CONT'D

Page

This page is intentionally blank.

LIST OF FIGURES

Page

LIST OF FIGURES CONT'D

Page

ACRONYMS, ABBREVIATIONS, AND SYMBOLS

46 OG/OGMTP	46th Test Wing Precision Strike Division
AAC	Air Armament Center
AAVs	Amphibious Assault Vehicles
ABR	Auditory Brainstem Response
ACC	Air Combat Command
ACM	Air Combat Maneuver
ADC	Acoustic Device Countermeasure
AEER	Advanced Extended Echo Ranging
AEGIS	Airborne Early Warning/Ground Environment Integration Segment
AEAU	Alternative Energy and Alternate Use
AES	Auditory-evoked Potential
AFAST	Atlantic Fleet Active Sonar Training
AFB	Air Force Base
AFSC	Alaska Fisheries Science Center
AFVOSF	Armored Fighting Vehicle Operational Storage Facility
Ag	Silver
AIC	Air Intercept Control
ALFS	Airborne Low-Frequency Sonar
AMCM	Airborne Mine Countermeasures
AMW	Amphibious Warfare
AOR	Area of Responsibility
ARG	Amphibious Ready Group
ARTCC	Air Route Traffic Control Center
ASA	American Sportfishing Association
ASW	Anti-Submarine Warfare
ATCAA	Air Traffic Control Assigned Airspace
AtoN	Aid to Navigation
AUTEC	Atlantic Undersea Test & Evaluation Center
AW	Air Warfare
AWOIS	Automated Wreck and Obstruction Information System
B.P.	Before Present
BA	Biological Assessment
bbl	Barrel
bbo	Billion Barrels of Oil
BE	Biological Evaluation
BO	Biological Opinion
BOMBEX	Bombing Exercise
BRAC	Base Realignment and Closure
BSS	Buoyancy Subsystem
°C	Degrees Celsius
can	Center for Naval Analysis
CCCL	Coastal Construction Control Line
CDC	Centers for Disease Control and Prevention
CENR	Committee on Energy and Natural Resources
CEQ	Council on Environmental Quality
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
CETAP	Cetacean and Turtle Assessment Program
CFR	Code of Federal Regulations
CFMETR	Canadian Forces Maritime Experimental and Test Ranges
CG	Cruiser, Guided Missile
CGS	Connecticut General Statute
CHASN	Charleston

ACRONYMS, ABBREVIATIONS, AND SYMBOLS CONT'D

CHPT	Cherry Point
CM	Countermeasure
cm	Centimeters
cm/sec	Centimeters per Second
CMP	Coastal Management Program
CNA	Center for Naval Analysis
CNMI	Commonwealth of Northern Mariana Islands
CNO	Chief of Naval Operations
CO	Carbon Monoxide
COMINEWARCOM	Mine Warfare Command
COMPTUEX	Composite Training Unit Exercises
CRU/DES	Cruiser/Destroyer
CSAR	Combat Search and Rescue
CSB	Cape San Blas
CSG	Carrier Strike Group
CSS	Confederate States Ship
CSTEE	Committee on Toxicity, Ecotoxicity and the Environment
CT	Computerized Tomography
Cu	Copper
CVN	Nuclear Aircraft Carrier
CW	Continuous Wave
CY	Calendar Year
CZMA	Coastal Zone Management Act
dB	Decibel(s)
dB re 1 μPa^2 s	dB Referenced to 1 Micropascal Squared Second
dB/μPa	dB Referenced to a Micropascal
dBA	A-Weighted Decibels
DDG	Guided Missile Destroyer
DDT	Dichlorodiphenyltrichloroethane
DEP	Department of Environmental Protection
DICASS	Directional Command-Activated Sonobuoy System
DIFAR	Directional Frequency Analysis and Recording
DMA	Dynamic Management Area
DOC	Department of Commerce
DoD	Department of Defense
DOE	Department of Energy
DOI	Department of the Interior
DON	Department of the Navy
DPS	Distinct Population Segment
DT	Developmental Test
DWRRA	Deep Water Royalty Relief Act
EA	Environmental Assessment
EC	Electronic Combat
ECM	Electronic Countermeasures
ECSWTR	East Coast Shallow Water Training Range
EEZ	Exclusive Economic Zone
EFD	Energy Flux Density
EFH	Essential Fish Habitat
EGTTR	Eglin Gulf Test and Training Range
EIS	Environmental Impact Statement
EIS/OEIS	Environmental Impact Statement/Overseas Environmental Impact Statement
EL	Energy Flux Density Level
EMATT	Expendable Mobile Acoustic Training Target
ENS	Environment News Service
EO	Executive Order

ACRONYMS, ABBREVIATIONS, AND SYMBOLS CONT'D

EOD	Explosive Ordnance Device
EPA	Environmental Protection Agency
EPAct	Energy Policy Act of 2005
ER	Ecological Reserve
ERL	Effects Range Low
ERM	Effects Range Median
ESA	Endangered Species Act
ESG	Expeditionary Strike Group
EWS	Early Warning System
EWTAs	Eglin Water Training Areas
°F	Degrees Fahrenheit
FAA	Federal Aviation Administration
FACSFAC	Fleet Air Control Surveillance Facility
FDA	Food and Drug Administration
FEIS	Final Environmental Impact Statement
FERC	Federal Energy Regulatory Commission
FFG	Fast Frigate
FIREX	Firing Exercise
FKNMS	Florida Keys National Marine Sanctuary
FM	Frequency Modulated
FMCs	Fishery Management Councils
FMRI	Florida Marine Research Institute
FR	Federal Register
FRP	Fleet Response Plan
FRTP	Fleet Response Training Plan
ft	Feet
ft/sec	Foot/feet per Second
ft^2	Square foot/feet
FWC	Florida Fish and Wildlife Conservation Commission
FY	Fiscal Year
g	Grams
g/L	Grams per Liter
GIS	Geographic Information System
GLO	General Land Office
GMFMC	Gulf of Mexico Fishery Management Council
GOMEX	Gulf of Mexico Exercises
GRN	Gulf Restoration Network
GUNEX	Gunnery Exercise
HAB	Harmful Algal Bloom
HARMEX	High-Speed Anti-Radiation Missile Exercise
HARPS	High Frequency Acoustic Recording Packages
HCN	Hydrogen Cyanide
HE	High Explosive
HLX	Cyclotetramethylenetetranitramine
HNS-IV	Hexanitrostilbene
hr	Hours
HSO_3	Bisulfite
Hz	Hertz
ICMP	Integrated Comprehensive Monitoring Process
ICUN	International Union for Conservation of Nature and Natural Resources (also known as World Conservation Union)
IEER	Improved Extended Echo Ranging
IFAW	International Fund for Animal Welfare
IHA	Incidental Harassment Authorization
IMPASS	Integrated Maritime Portable Acoustic Scoring and Simulator
in	Inches

ACRONYMS, ABBREVIATIONS, AND SYMBOLS CONT'D

in/sec	Inches per Second
in-lb/in^2	Inch Pounds per Square Inch
ITS	Incidental Take Statement
IUPAC	International Union of Pure and Applied Chemistry
IWC	International Whaling Commission
JASSM	Joint Air-to-Surface Stand-off Missile
JAX	Jacksonville
JAX/CHASN	Jacksonville/Charleston
JAXPORT	Jacksonville Port Authority
JNTC	Joint National Training Capability
JTA	Joint Test Assembly
JTFEX	Joint Task Force Exercises
kg	Kilograms
kHz	Kilohertz
km	Kilometers
km/hr	Kilometers per Hour
km^2	Square Kilometers
kn	Knot
kPa	Kilopascal
K_{sp}	Dissociation Constant
L	Liters
lb	Pounds
LCAC	Landing Craft Air Cushion
LCU	Landing Craft Utility
LDEO	Lamont-Doherty Earth Observatory
LFA	Low-Frequency Active (Sonar)
LHD	Amphibious Assault Ships
LIMPET	Land Installed Marine Powered Energy Transformer
LLC	Limited Liability Company
L_{max}	Maximum Sound Level
LNG	Liquefied Natural Gas
LOA	Letter of Authorization
LOE	Limited Objective Experiment
LPD	Amphibious Transport Dock Ships
LSD	Dock Landing Ships
LWAD	Littoral Warfare Advanced Development
m	Meter(s)
m/sec	Meter(s) per Second
m^2	Square Meter(s)
m^3	Cubic Meters
MAB	Mid-Atlantic Bight
MARAD	Maritime Administration
MAUS	Mid-Atlantic United States
MBTA	Migratory Bird Treaty Act
MCAS	Marine Corps Air Station
MCB	Marine Corps Base
MCC	Maine Coastal Current
Mcf	Thousand Cubic Feet
MCM	Mine Countermeasures
MEU	Marine Expeditionary Unit
µg	Microgram(s)
µg/L	Microgram(s) per Liter
mg	Milligram(s)
mg/hr	Milligram(s) per Hour
mg/L	Milligram(s) per Liter
mg/m^3	Milligrams per Cubic Meter

ACRONYMS, ABBREVIATIONS, AND SYMBOLS CONT'D

mg/sec	Milligram(s) per Second
MHz	Megahertz
mi	Mile(s)
mi^2	Square Miles
min	Minutes
MINEX	Mine Warfare Exercises
MISSILEX	Missile Exercise
MIW	Mine Warfare
mL	Milliliters
MLO	Mine-Like Objects
µm	Micrometers
mm	Millimeter
MMC	Marine Mammal Commission
MMHSRA	Marine Mammal Health and Stranding Response Act
MMHSRP	Marine Mammal Health and Stranding Response Program
MMPA	Marine Mammal Protection Act
MMS	Minerals Management Service
MOA	Military Operations Area
MOU	Memorandum of Understanding
MOUT	Military Operations in Urban Terrain
µPa	Micropascal
µPa-m	Micropascal-meter
MPA	Marine Protected Area
MPRSA	Marine Protection, Research and Sanctuaries Act
MRA	Marine Resource Assessment
µs	Microsecond (one millionth of a second)
MSA	Magnuson-Stevens Fishery Conservation and Management Act
MSAT	Marine Species Awareness Training
msec	Milliseconds
MW	Megawatts
N	North
NAAQS	National Ambient Air Quality Standards
NAE	Noise Acoustic Emitter
NAMMCO	North Atlantic Marine Mammal Commission
NAO	Atlantic Ocean Oscillation
NARR	Narragansett
NAS	Naval Air Station
NASA	National Aeronautics and Space Administration
NATO	Atlantic Ocean Treaty Organization
NATO	North Atlantic Treaty Organization
NAVEDTRA	Naval Education and Training Command Manual
NAVFAC	Naval Facilities Engineering Command
NAVSEAINST	Naval Sea Systems Command Instruction
NDAA	National Defense Authorization Act
NEODS	Naval Explosive Ordnance Disposal School
NEPA	National Environmental Policy Act of 1969
NEPM	Non-Explosive Practice Munitions
NEUS	Northeastern United States
NEW	Net Explosive Weight
NFWF	National Fish and Wildlife Foundation
NM	Nautical Miles
NM/hr	Nautical Miles per Hour
NM^2	Square Nautical Miles
NMFS	National Marine Fisheries Service
NMS	National Marine Sanctuaries
NMSA	National Marine Sanctuaries Act

NMMTB	National Marine Mammal Tissue Bank
NMSP	National Marine Sanctuary Program
NOAA	National Oceanic and Atmospheric Administration
NODE	Navy OPAREA Density Estimate
NOI	Notice of Intent
NOSC	Naval Ocean Systems Center
NOTAM	Notice to Airmen
NOTMAR	Notice to Mariners
NO_x	Nitrogen Oxides
NPAL	North Pacific Acoustic Laboratory
NPDES	National Pollutant Discharge Elimination System
NPS	National Park Service
NRC	National Research Council of the National Academies
NRC	Nuclear Regulatory Commission
NRL	Naval Research Laboratory
NS	Naval Station
NSB	Naval Submarine Base
NSFS	Naval Surface Fire Support
NSW	Naval Special Warfare
NSWC PCD	Naval Surface Warfare Center Panama City Division
NUWCDIVNPT	Naval Undersea Warfare Center Division Newport
OCGA	Official Code of Georgia
OCS	Outer Continental Shelf
OCSLA	Outer Continental Shelf Lands Act
OEA	Overseas Environmental Assessment
OEIS	Overseas Environmental Impact Statement
OF II	Otto Fuel II
ONR	Office of Naval Research
OPAREA	Operating Area
OPCON	Operational Control
OPNAVINST	Chief of Naval Operations Environmental and Natural Resources Program Manual Instruction
ORPC	Ocean Renewable Power Company
OT	Operational Test
OTC	Officer in Tactical Command
PAA	Planning Awareness Area
PADI	Professional Association of Diving Instructors
PAM	Passive Acoustic Monitoring
Pb	Lead
PBR	Potential Biological Removal
PBXN	Plastic Bonded Explosive
PCB	Polychlorinated Biphenyl
PCOLA	Naval Air Station Pensacola
PFP	Proposed Final Program
PL	Public Law
PM_{10}	Particulate Matter Less Than 10 Microns in Diameter
PMRF	Pacific Missile Range Facility
PNEC	Probable No Effect Concentration
ppt	Parts per Thousand
PQS	Personal Qualification Standard
PROMAR	Program on the Promotion of Marine Sciences
psi	Pounds per Square Inch
psi-ms	Pounds per Square Inch-Millisecond
psu	Practical Salinity Units
PSW	Precision Strike Weapons
PTS	Permanent Threshold Shift

ACRONYMS, ABBREVIATIONS, AND SYMBOLS CONT'D

RDT&E	Research, Development, Test, and Evaluation
RDX	Research Department Explosive
re 1 µPa-m	Reference Pressure of 1 Micropascal at 1 Meter
RIMPAC	Rim of the Pacific
RITE	Roosevelt Island Tidal Energy
rms	Root Mean Square
ROD	Record of Decision
RONEX	Squadron Exercise
ROW	Rights-of-Way
s.d.	Standard Deviations
SAB	South Atlantic Bight
SAFMC	South Atlantic Fishery Management Council
SAG	Surface-Active Group
SAS	Sighting Advisory System
SCC	Submarine Command Course
SCSPA	South Carolina State Ports Authority
SDB	Small-Diameter Bomb
SEAL	Sea, Air, Land (U.S. Navy special forces team member)
SEASWITI	Southeastern Anti-Submarine Warfare Integrated Training Initiative
sec	Seconds
SEL	Sound Exposure Level
SESEF	Shipboard Electronic Systems Evaluation Facility
SEUS	Southeastern United States
SHAREM	Ship ASW Readiness/Effectiveness Measuring
SHPO	State Historic Preservation Officer
SINKEX	Sinking Exercise of Surface Targets
SMA	Seasonal Management Area
SO_x	Sulfur Oxides
SPA	Sanctuary Preservation Area
SPAWAR	Space and Naval Warfare Systems Command
SPL	Sound Pressure Level
SPORTS	Sonar Positional Reporting System
SRI	Santa Rosa Island
SSBN	Ballistic Nuclear Submarine
SSC	Surveillance Support Center
SSGN	Nuclear Guided Missile Submarine
SSN	Attack Submarine (nuclear powered)
SST	Sea Surface Temperature
STW	Strike Warfare
SUA	Special Use Airspace
SUS	Signal Underwater Sound
SURTASS	Surveillance Towed Array Sensor System
SW	Surface Warfare
SWSS	Sperm Whale Seismic Survey
TA	Test Area
T.A.C	Texas Administrative Code
TAP	Tactical Training Theater Assessment and Planning Program
TBD	To Be Determined
TCFG	Trillion Cubic Feet of Gas
TEDs	Turtle Excluder Devices
TEU	Twenty-Foot Equivalent Units
TGLO	Texas General Land Office
THC	Texas Historic Commission
TL	Transmission Loss
TM	Tympanic-membrane
TORPEX	Torpedo Exercise

ACRONYMS, ABBREVIATIONS, AND SYMBOLS CONT'D

TPWD	Texas Parks and Wildlife Department
TS	Threshold Shift
TTS	Temporary Threshold Shift
U.S.	United States
UERR	Undiscovered Economically Recoverable Resources
ULT	Unit Level Training
UME	Unusual Mortality Event
UNDET	Underwater Detonation
USACE	U.S. Army Corps of Engineers
USC	United States Code
USCG	U.S. Coast Guard
USEPA	U.S. Environmental Protection Agency
USFWS	U.S. Fish and Wildlife Service
USS	U.S. Ship
USWTR	Undersea Warfare Training Range
UTRR	Undiscovered Technically Recoverable Resources
UUV	Unmanned Underwater Vehicle
VAC	Virginia Capes
VAST/IMPASS	Virtual At-Sea Training/Integrated Maritime Portable Acoustic Scoring and Simulator
VBSS/MIO	Visit, Board, Search, and Seizure/Maritime Interdiction Operations
VCOA	Virginia Capes
VEMs	Versatile Exercise Mines
VOCs	Volatile Organic Compounds
°W	Degrees West
WA	Warning Area
WDCS	Whale and Dolphin Conservation Society
WFF	Wallops Flight Facility
WHOI	Woods Hole Oceanographic Institution
WMA	Wildlife Management Area
WR	War Reserve
WSEP	Weapons Systems Evaluation Program
WTP	Willingness-To-Pay
XBT	Expendable Bathythermograph
yd	Yards
yr	Year

EXECUTIVE SUMMARY

ES.1 INTRODUCTION

This Atlantic Fleet Active Sonar Training (AFAST) Environmental Impact Statement/Overseas Environmental Impact Statement (EIS/OEIS) analyzes the potential environmental effects associated with the Proposed Action, which is the designation of sonar use areas and use of active sonar technology and the improved extended echo ranging (IEER) system during Atlantic Fleet training exercises and to conduct these activities. The IEER system consists of an explosive source sonobuoy (AN/SSQ-110A) and an air deployable active receiver (ADAR) sonobuoy (AN/SSQ-101). The Navy is developing the Advanced Extended Echo Ranging (AEER) system as a replacement to the IEER system. The AEER system would use a new active sonobuoy (AN/SSQ-125) that utilizes a tonal (or a ping) versus an impulsive (or explosive) sound source as a replacement for the AN/SSQ-110A. The AEER system will still use the ADAR sonobuoy as the systems receiver. The Proposed Action would support and maintain Navy Atlantic Fleet training, as well as maintenance and research, development, test, and evaluation (RDT&E) for mid- and high frequency active sonar that is coincident and substantially similar to Atlantic Fleet training activities. For the purposes of this document, training, maintenance, and RDT&E activities involving active sonar and the explosive source sonobuoy (AN/SSQ-110A) are collectively described as active sonar activities. The activities involving active sonar described in this EIS/OEIS are not new and do not involve significant changes in systems, tempo, or intensity from past activities. In addition, the Navy has made changes to this AFAST Final EIS/OEIS based on comments received during the public comment period. These changes included factual corrections, additions to existing information, and improvements or modifications to the analyses presented in the AFAST Draft EIS/OEIS. A summary of public comments received and the Navy's response to these comments is provided in Appendix J. (All comment letters are available on the project website, http://afasteis.gcsaic.com.) None of the changes between the Draft and Final EIS/OEIS resulted in substantive changes to the Proposed Action, alternatives, or the significance of the environmental consequences of the Proposed Action.

This EIS/OEIS complies with the National Environmental Policy Act of 1969 (NEPA) (42 United States Code [U.S.C.] Sections 4321 to 4370f [42 U.S.C. 4321 to 4370f]); the Council on Environmental Quality (CEQ) Regulations for Implementing the Procedural Provisions of NEPA (Title 40 Code of Federal Regulations, Sections 1500 to 1508 (40 CFR 1500-1508); Department of the Navy Procedures for Implementing NEPA (32 CFR 775); and Executive Order (EO) 12114, *Environmental Effects Abroad of Major Federal Actions*. This EIS/OEIS satisfies the requirements of NEPA and EO 12114, and was filed with the United States (U.S.) Environmental Protection Agency (EPA), and distributed or otherwise made available to appropriate federal, state, local, and private agencies, organizations, and individuals for review and comment.

In an effort to address the requirements set forth within NEPA, the AFAST EIS/OEIS discloses potential impacts and informs decision makers and the public of the reasonable alternatives to the Proposed Action. Impacts to ocean areas of the AFAST Study Area that lie within 22.2 kilometers (km) (12 nautical miles [NM]) of land (territorial seas) are subject to analysis under NEPA. This is based on Presidential Proclamation 5928, issued December 27, 1988, in which the

United States extended its exercise of sovereignty and jurisdiction under international law to 22.2 km (12 NM) from land, although the Proclamation expressly provides that it does not extend or otherwise alter existing federal law or any associated jurisdiction, rights, legal interests, or obligations.

EO 12114 directs federal agencies to provide for informed decision making for major federal actions outside the United States, including the global commons, or harm to protected global resources. An OEIS is required when an action has the potential to significantly harm the environment of the global commons. "Global commons" are defined as "geographical areas that are outside of the jurisdiction of any nation, and include the oceans outside territorial limits (outside 22.2 km [12 NM] from the coast) and Antarctica. Global commons do not include contiguous zones and fisheries zones of foreign nations" (32 CFR 187.3). Effects to areas within the AFAST Study Area that lie outside 22.2 km (12 NM) are analyzed using the procedures set out in EO 12114 and associated implementing regulations.

NEPA and EO 12114 require an assessment of the Proposed Action's potential effects occurring within and outside U.S. territory; therefore, this document was prepared as an EIS/OEIS under the authorities of both. In addition to NEPA and EO 12114, this document complies with a variety of other environmental regulations. Refer to Section 1.4 for additional information.

The Navy's mission to maintain, train, and equip combat-ready naval forces capable of winning wars, deterring aggression, and maintaining freedom of the seas is mandated by federal law (10 U.S.C. 5062), which charges the Chief of Naval Operations (CNO) with the responsibility of ensuring the readiness of the nation's naval forces. The CNO meets this directive, in part, by establishing and executing training programs that include at-sea training exercises to develop and maintain skills necessary for the conduct of naval operations. RDT&E and maintenance activities are an integral part of this readiness mandate. For purposes of this EIS/OEIS, exercises and training do not include activities conducted as a part of actual combat, activities in direct support of combat, or other activities conducted primarily for purposes other than training.

Specifically, the training addressed by the Proposed Action consists of operating mid- and high frequency active sonar systems in a realistic environment to maximize operator familiarity. Active sonar, and expertise in its use, is essential to successful at-sea operations. The rapid worldwide proliferation of modern, quiet, and relatively inexpensive diesel submarines has made active sonar a critical component to our Navy, as this is the best method available to counter the threat of an unseen modern diesel submarine. As such, sonar operators must be skilled in the complexities of active sonar operation and analysis, and must maintain this expertise.

The AFAST Study Area associated with the proposed Atlantic Fleet training activities encompasses the waters and their associated substrates within and adjacent to existing Operating Areas (OPAREAs), located along the East Coast and within the Gulf of Mexico as depicted in Figure ES-1. These Navy OPAREAs include designated ocean areas near fleet concentration areas (i.e., homeports) where the majority of routine Navy training and RDT&E occur.

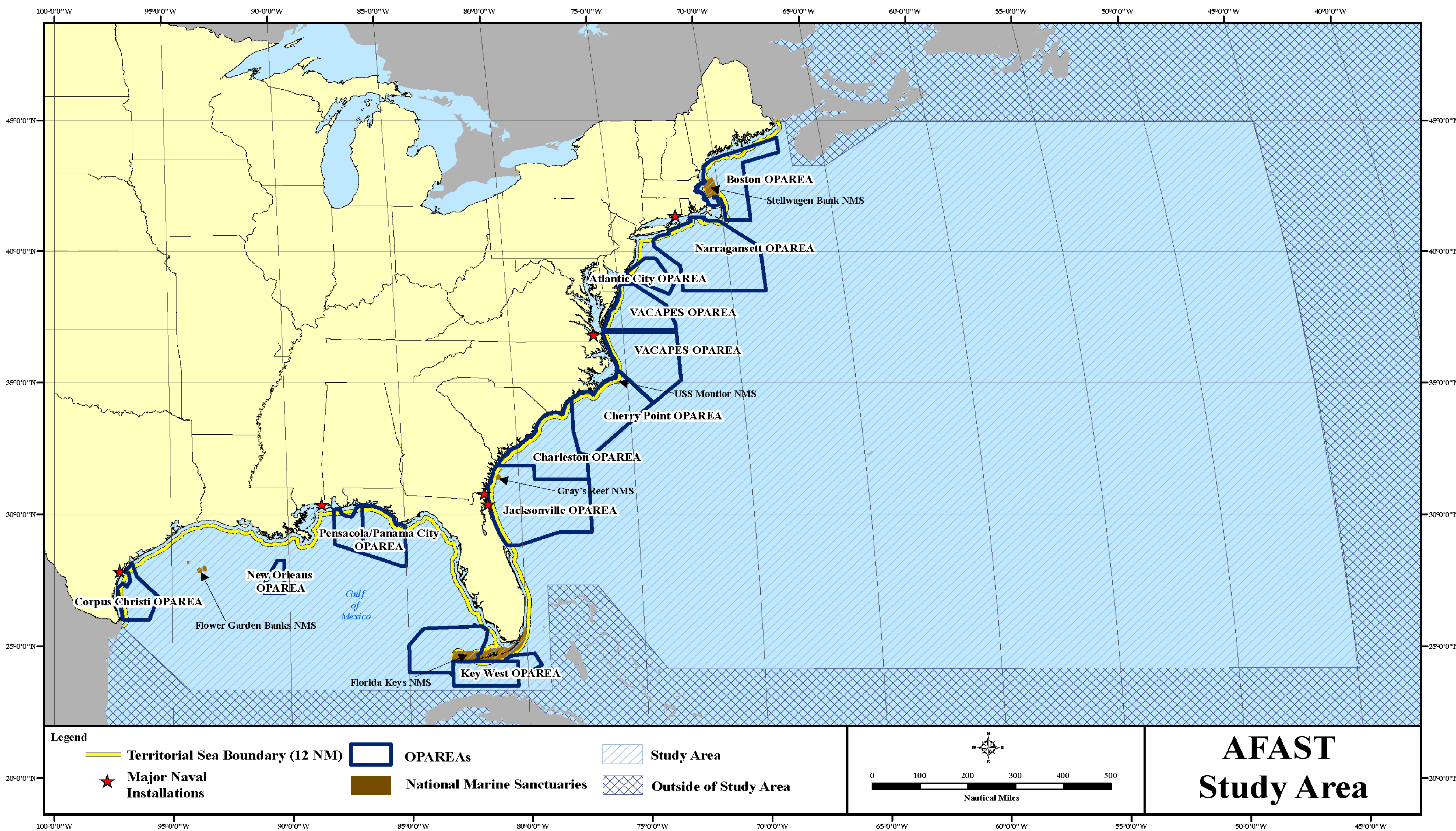


Figure ES-1. Overall Atlantic Fleet Study Area

This page is intentionally blank.

Navy training exercises are not confined to the OPAREAs; some active sonar activities or portions of these activities are conducted seaward of the OPAREAs, and a limited amount of active sonar use is conducted shoreward of the OPAREAs.

ES.2 PURPOSE AND NEED

The purpose of the Proposed Action is to provide active sonar training for U.S. Navy Atlantic Fleet ship, submarine, and aircraft crews, and to conduct RDT&E activities to support the requirements of the Fleet Response Training Plan (FRTP) and stay proficient in Anti-Submarine Warfare (ASW) and Mine Warfare (MIW) skills. The FRTP is the Navy's training cycle that enables naval forces to develop combat skills in preparation for operational deployment and to maintain a high level of proficiency and readiness while deployed.

The need for active sonar training and RDT&E activities is based on 10 U.S.C. 5062. Title 10 U.S.C. 5062 requires the Navy to be "organized, trained, and equipped primarily for prompt and sustained combat incident to operations at sea." The current and emerging training, maintenance, and RDT&E activities addressed in this EIS/OEIS are conducted in fulfillment of this legal requirement.

ES.3 PUBLIC INVOLVEMENT

The Navy initiated a mutual exchange of information through early and open communications with interested stakeholders during the development of this EIS/OEIS. The notice of intent, which provides an overview of the proposed project and the scope of the EIS/OEIS, was published in the *Federal Register* on September 29, 2006 (DON, 2006b). As shown in Table ES-1, the Navy held eight scoping meetings during which naval staff and subject matter experts presented information using display boards and fact sheets in an open house format, as well as answered questions from attendees.

Table ES-1. Scoping Meeting Locations and Dates

Location	Date	Facility
Chesapeake, Virginia	October 23, 2006	Chesapeake Conference Center, 900 Greenbrier Circle
Corpus Christi, Texas	October 26, 2006	American Bank Center, 1901 North Shoreline Boulevard
New London, Connecticut	November 2, 2006	Radisson Hotel, 35 Governor Winthrop Boulevard
Jacksonville, Florida	November 7, 2006	Ramada Inn Mandarin, 3130 Hartley Road
Panama City, Florida	November 9, 2006	Marriot Bay Point Resort, 4200 Marriot Drive
Morehead City, North Carolina	November 14, 2006	National Guard Armory, 3609 Bridge Street
Charleston, South Carolina	November 16, 2006	Town and Country Inn (Conference Center), 2008 Savannah Highway
New London, Connecticut	November 29, 2006	Radisson Hotel, 35 Governor Winthrop Boulevard

The scoping comment period lasted 78 days. The public submitted comments at the scoping meetings and also through fax, U.S. mail, and the AFAST EIS/OEIS website (http://afasteis.gcsaic.com). By December 16, 2006, agencies, organizations, and individuals had submitted 131 written and electronic comments. All scoping comments were reviewed and applicable issues are addressed in this EIS/OEIS.

Following the public scoping process, the AFAST Draft EIS/OEIS was prepared to provide an assessment of the potential effects of the Proposed Action on the human or natural environment. The document also informed decision makers and the public of reasonable alternatives that would avoid or minimize adverse effects or enhance the quality of the environment.

Upon release of the AFAST Draft EIS/OEIS, a notice of availability/notice of public hearings was published in the *Federal Register* on February 15, 2008 (DON, 2008a). The document was then distributed to those individuals, agencies, and associations listed in Appendix B, Table B-1. In addition, notification of the availability of the Draft EIS/OEIS and public hearing schedule was sent to those individuals, agencies, and associations listed in Appendix B, Table B-2. In addition, the AFAST Draft EIS/OEIS was also made available for general review in 11 public libraries listed in Table B-1, as well as on the project website. Public hearings were held following the release of the AFAST Draft EIS/OEIS to seek additional public comment on the document.

The public review period ended on March 31, 2008. As shown in Table ES-2, the Navy held six public hearings during which naval staff and subject matter experts presented information using display boards and fact sheets in an open house format. Immediately following the open house, a formal presentation was held followed by an opportunity for the public to comment.

Table ES-2. Public Hearing Locations and Dates

Location	Date	Facility
Virginia Beach, Virginia	March 4, 2008	Tidewater Community College, Advanced Technology Center: Technology Theater, Faculty Drive
Boston, Massachusetts	March 6, 2008	Boston University, Kenmore Classroom Building, Room 101, 565 Commonwealth Avenue
Morehead City, North Carolina	March 11, 2008	Crystal Coast Civic Center, 3505 Arendall Street
Mount Pleasant, South Carolina	March 13, 2008	Charleston Harbor Resort and Marina, Atlantic Ballroom, 20 Patriots Point Road
Jacksonville, Florida	March 18, 2008	Florida Community College at Jacksonville, Nathan H. Wilson Center for the Arts: Lakeside Conference Room, 11901 Beach Boulevard
Panama City, Florida	March 19, 2008	Florida State University, Panama City Campus, Auditorium, 4750 Collegiate Drive

The entire public comment review period lasted 45 days, from the date the Draft EIS/OEIS was released on February 15, 2008, to March 31, 2008. Comments were submitted at the public hearing meetings (written and oral), through fax, U.S. mail, and the AFAST EIS/OEIS website (i.e., http://afasteis.gcsaic.com). By the close of the comment period, a total of 214 agencies, organizations, and individuals had submitted 1,607 comments. This Final EIS/OEIS incorporates and formally responds to all substantive comments received on the Draft EIS/OEIS. Refer to Appendix J for additional information, including responses to comments.

The notice of availability of this Final EIS/OEIS was published in the *Federal Register*, in various newspapers, and on the AFAST EIS/OEIS website. Release of the Final EIS/OEIS is accompanied by a 30-day wait period, unless otherwise approved by the Environmental

Protection Agency (EPA). The EPA may, upon a showing by the lead agency of compelling reasons of national policy, reduce the prescribed periods and may, upon a showing by any other Federal agency of compelling reasons of national policy, also extend prescribed periods, but only after consultation with the lead agency.

ES.4 PROPOSED ACTION AND ALTERNATIVES

The Proposed Action is to designate areas where mid- and high-frequency active sonar and IEER system training, maintenance, and RDT&E activities will occur within and adjacent to existing OPAREAs and to conduct these activities. NEPA-implementing regulations provide guidance on the consideration of alternatives in an EIS. These regulations require the decision maker to consider the environmental effects of the Proposed Action and a range of alternatives to the Proposed Action (40 CFR 1502.14). The range of alternatives includes reasonable alternatives, which must be rigorously and objectively explored, as well as other alternatives that are eliminated from detailed study. To be "reasonable," an alternative must meet the stated purpose of and need for the Proposed Action.

Section 2.4 describes the operational requirements associated with the active sonar activities and Section 2.6.2 describes the process for developing alternatives. Specifically, the Navy used the following process in developing the criteria to be used during alternatives identification:

(1) Define the operational requirements needed to effectively meet Navy training requirements. This was achieved using operator input for ASW and MIW training requirements, as well as information from Navy Systems Commands regarding RDT&E requirements.

(2) Use the requirements defined in Step 1 (e.g. the size of the area, the water depth, or the bottom type needed for a particular training event) to identify the feasible active sonar locations.

(3) Using the locations identified in Step 2, the surrogate environmental analysis was conducted to analyze the relative sound exposures of marine mammals. This surrogate analysis provided a relative comparison of the number of marine mammal exposures that would be estimated in a given area during a given season, providing a basis from which geographic and seasonal alternatives were developed for full analysis in this EIS/OEIS. The surrogate analysis allowed alternatives to be developed based on the potential to reduce the number of marine mammal exposures while supporting the conduct of required active sonar activities. These locations were carried forward as reasonable alternatives for analysis of all active sonar activities and sonar hours described in this EIS/OEIS (see Appendix D, Description of Alternative Development).

(4) U.S. Fleet Forces (USFF) was able to consider biological factors such as animal densities and unique habitat features because of geographic flexibility in conducting ASW training. USFF is not tied to a specific range support structure for the majority of the training. Additionally, the topography and bathymetry along the East Coast and in the Gulf of Mexico is unique in that there is a wide continental shelf leading to the shelf break affording a wider range of training opportunities.

The operational requirements discussed in Section 2.4 were used as the screening criteria. If an alternative did not meet one or more of the selection criteria, the alternative was not considered reasonable and was not further analyzed. Four reasonable alternatives, including the No Action Alternative, are analyzed in this EIS/OEIS. Under all four alternatives, only active sonar systems with an operating frequency less than 200 kilohertz (kHz) were analyzed. Active sonar systems with an operating frequency greater than 200 kHz were not analyzed, as these signals attenuate rapidly during propagation (30 decibels per kilometer [dB/km] or more absorption losses), resulting in very short propagation distances. In addition, such frequencies are outside the known hearing range of most marine mammals.

Under Alternative 1, Designated Active Sonar Areas (Figure ES-2), fixed active sonar areas would be designated using an environmental analysis to determine locations that would minimize environmental effects to biological resources while still meeting operational requirements. These areas would be available for use year-round. Under Alternative 2, Designated Seasonal Active Sonar Areas (Figures ES-3 through ES-6), active sonar training areas would be designated using the same environmental analysis conducted under Alternative 1. The areas would be adjusted seasonally to minimize effects to marine resources while still meeting minimum operational requirements (more detailed figures are included in Chapter 2). Under Alternative 3, Designate Areas of Increased Awareness (Figure ES-7), the results of the environmental analysis conducted for Alternative 1 and 2 were utilized in conjunction with a qualitative environmental analysis of sensitive habitats to identify areas of increased awareness. Active sonar would not be conducted within these areas of increased awareness. The No Action Alternative can be regarded as continuing with the present course of action. Under the No Action Alternative (Figure ES-8), the Navy would continue conducting active sonar activities within and adjacent to existing OPAREAs, within the Study Area, rather than designate active sonar areas or areas of increased awareness. Under the No Action Alternative, Alternative 1, Alternative 2, and Alternative 3, the U.S. Navy does not plan to conduct active sonar activities within the Stellwagen Bank, Monitor, Gray’s Reef, Flower Garden Banks, and Florida Keys National Marine Sanctuaries and will avoid these sanctuaries by observing a 5 km (2.7 NM) buffer. At all times, the Navy will conduct AFAST activities in a manner that avoids to the maximum extent practicable any adverse impacts on sanctuary resources. In the event the Navy determines AFAST activities, due to operational requirements, are likely to destroy, cause the loss of, or injure any sanctuary resource (for Stellwagen Bank National Marine Sanctuary, the threshold is “may” destroy, cause the loss of, or injure), the Navy would first consult with the Director, Office of National Marine Sanctuaries in accordance with 16 U.S.C. 1434(d).

Through careful consideration of the data developed in this EIS/OEIS, and the necessity to conduct realistic ASW training today and in the future, the U.S. Fleet Forces (USFF) has selected the No Action Alternative as the operationally preferred alternative. The world today is a rapidly changing and extremely complex place. This is especially true in the arena of ASW and the scientific advances in submarine quieting technology. Not only is this technology rapidly improving, the availability of these quiet submarines has also significantly increased. Since these submarines typically operate in coastal regions, which are the most difficult acoustically to conduct ASW, the Navy needs to ensure it has the ability to train in areas that are environmentally similar to where these submarines currently operate, as well as areas that may

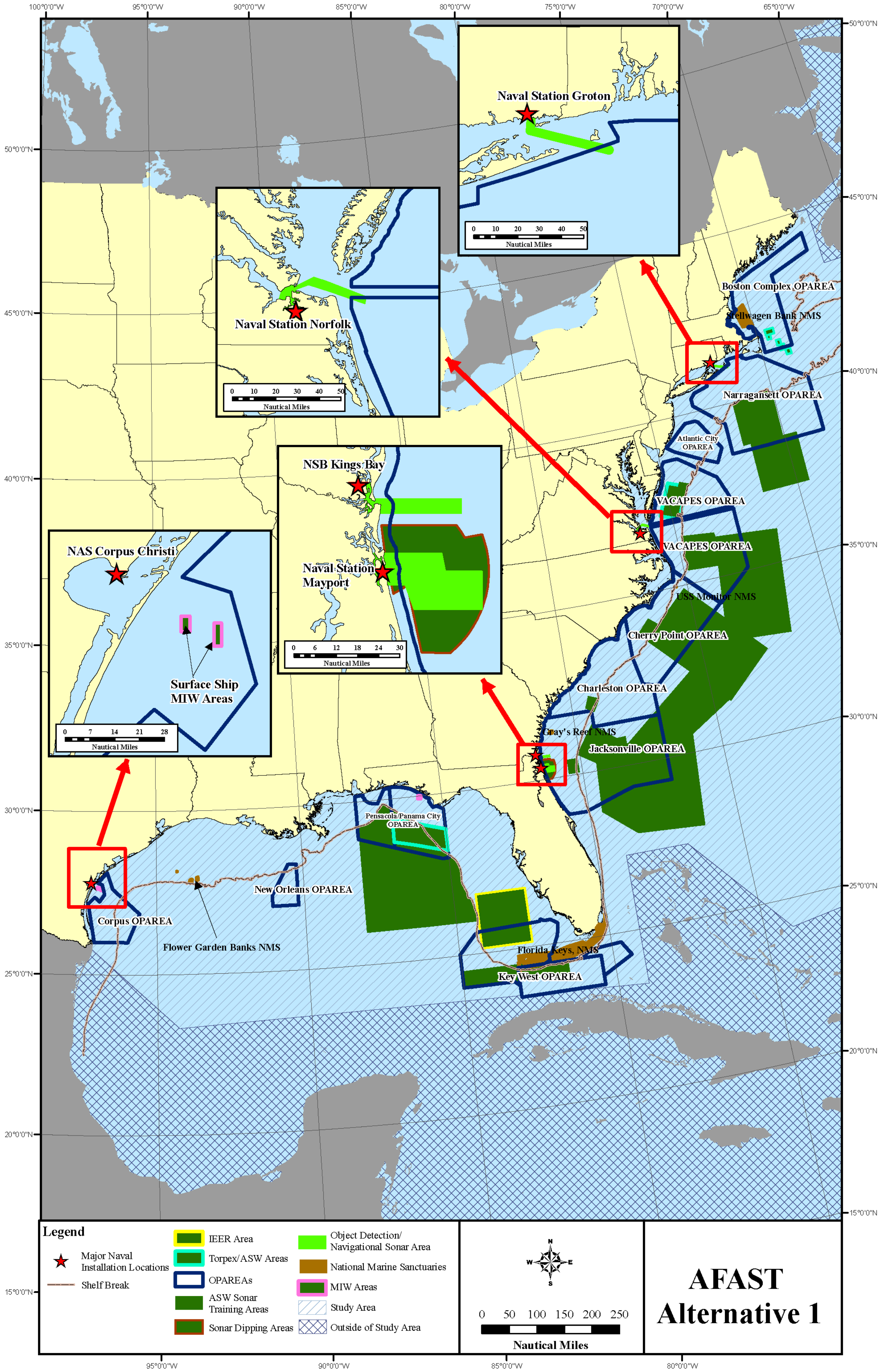


Figure ES-2. Alternative 1 – Active Sonar Activities would occur in Designated Areas (Overall)

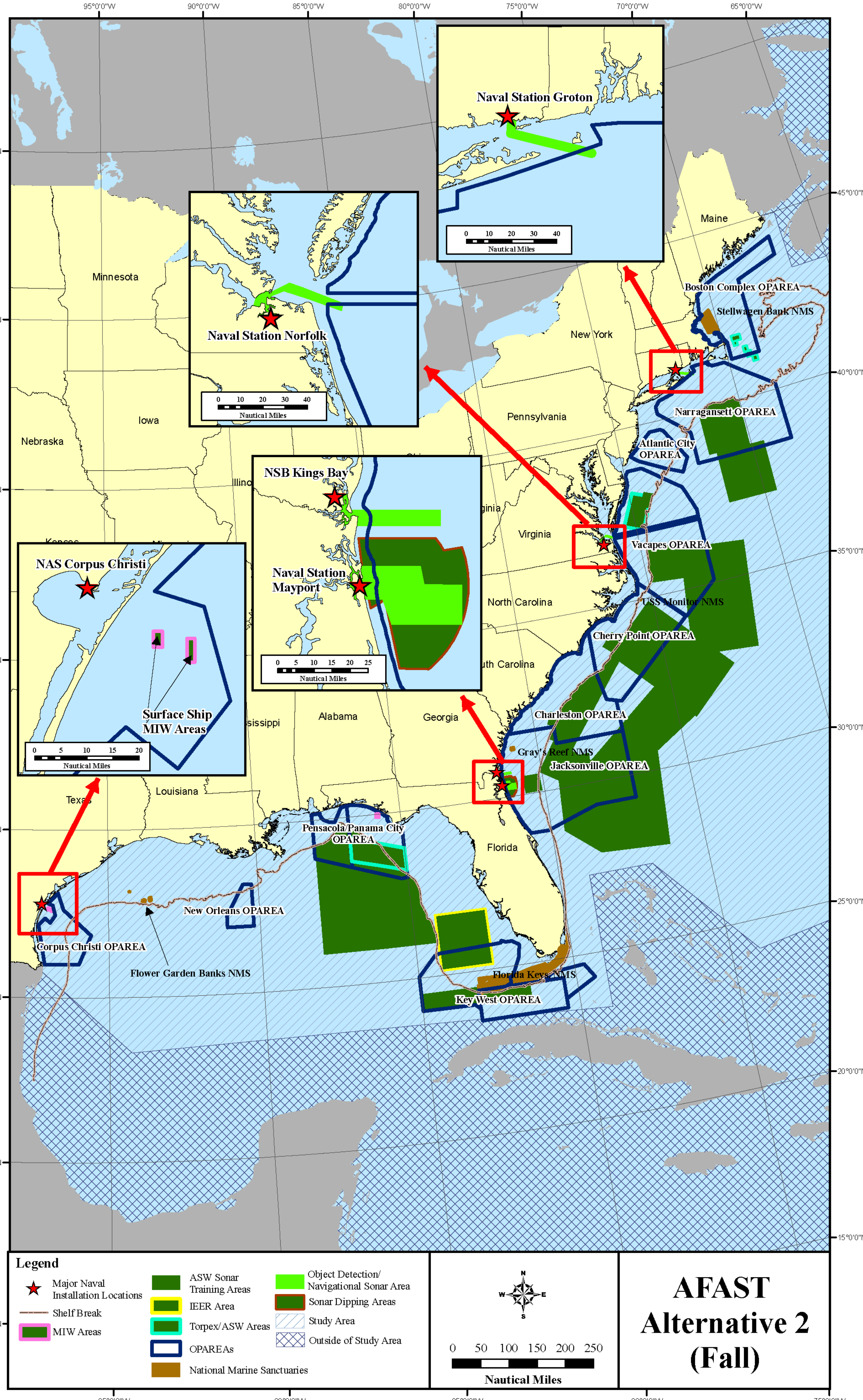


Figure ES-3. Alternative 2 – Active Sonar Activities would occur in Designated Areas (Overall–Fall)

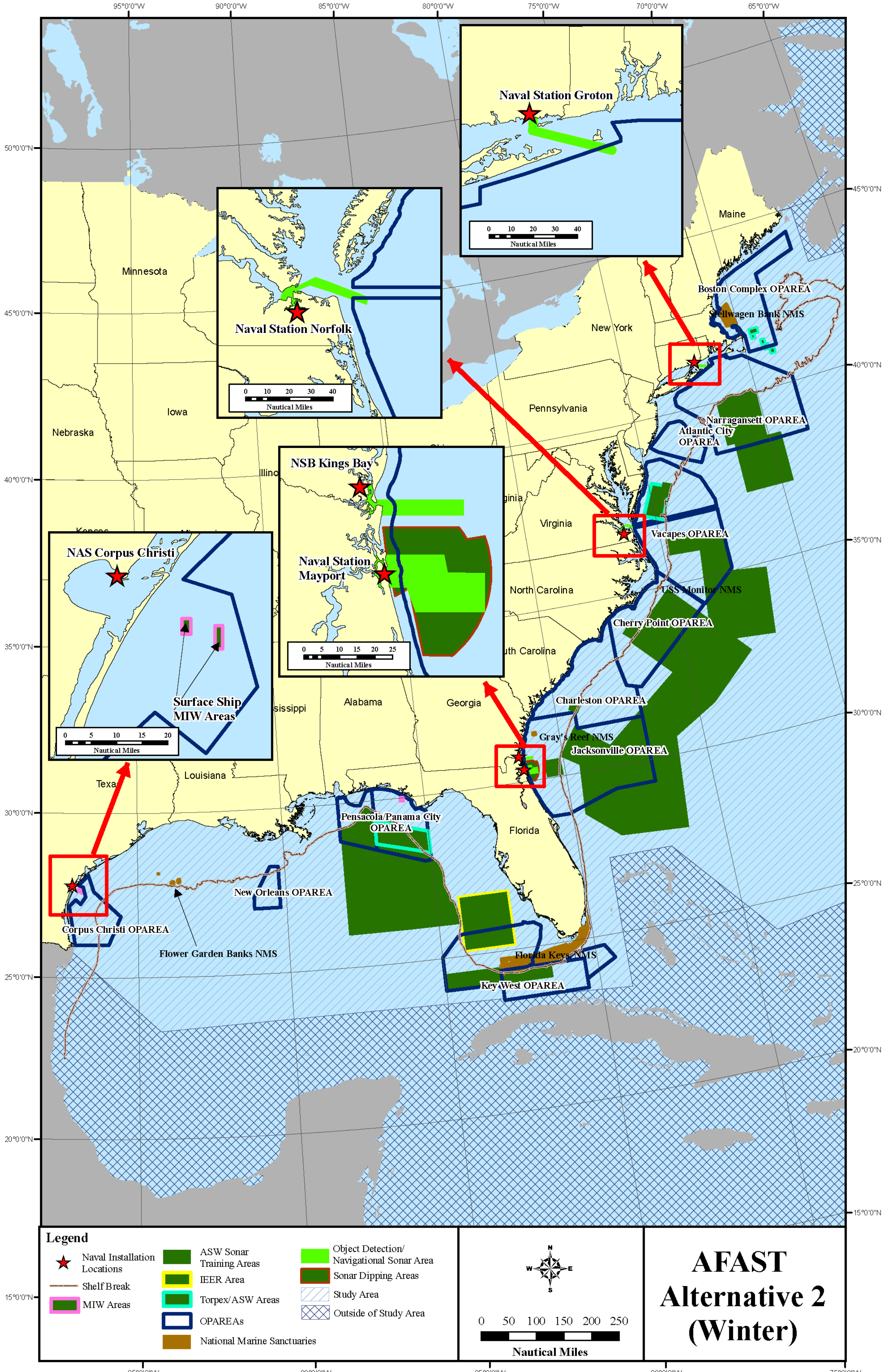


Figure ES-4. Alternative 2 – Active Sonar Activities would occur in Designated Areas (Overall–Winter)

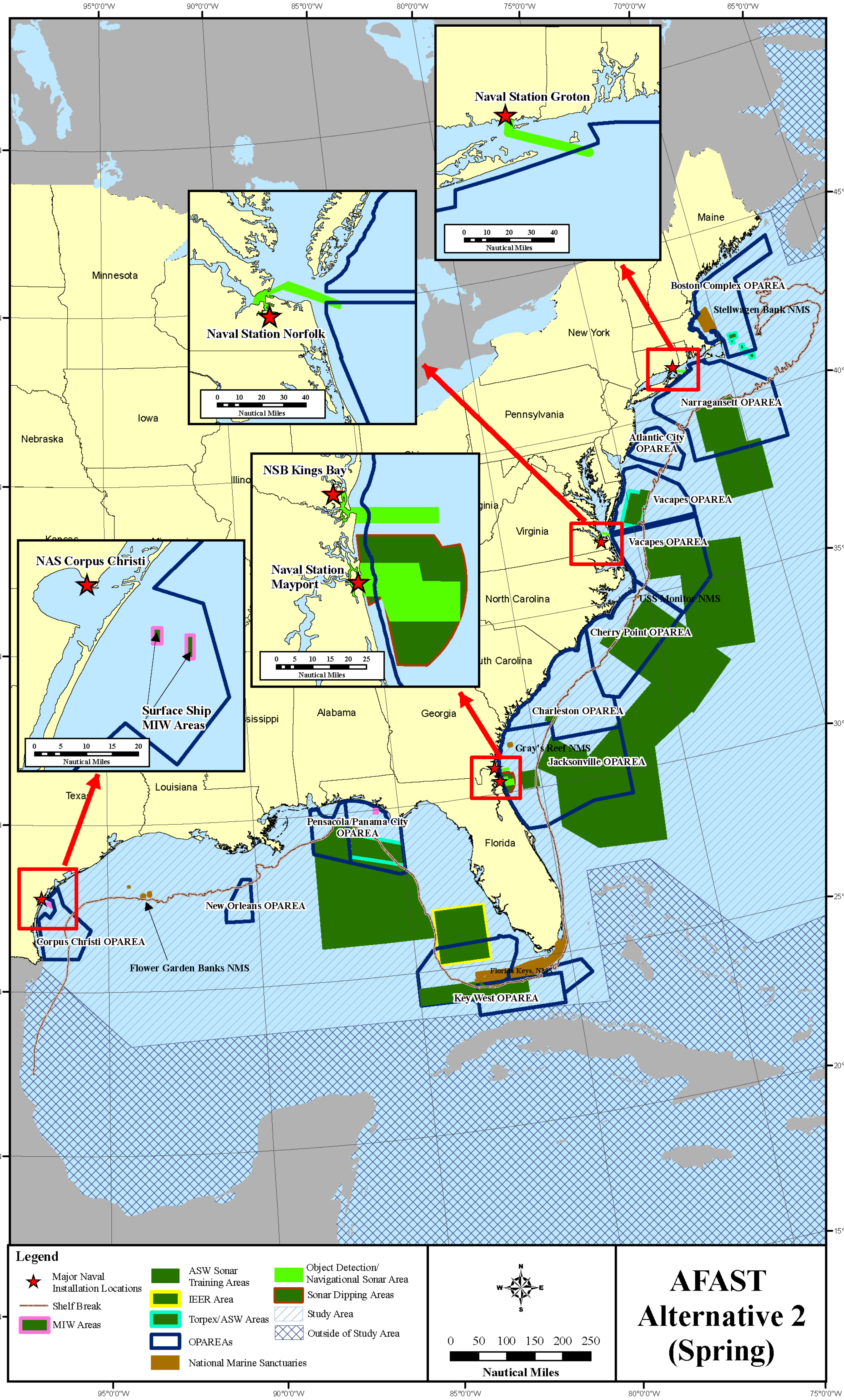


Figure ES-5. Alternative 2 – Active Sonar Activities would occur in Designated Areas (Overall–Spring)

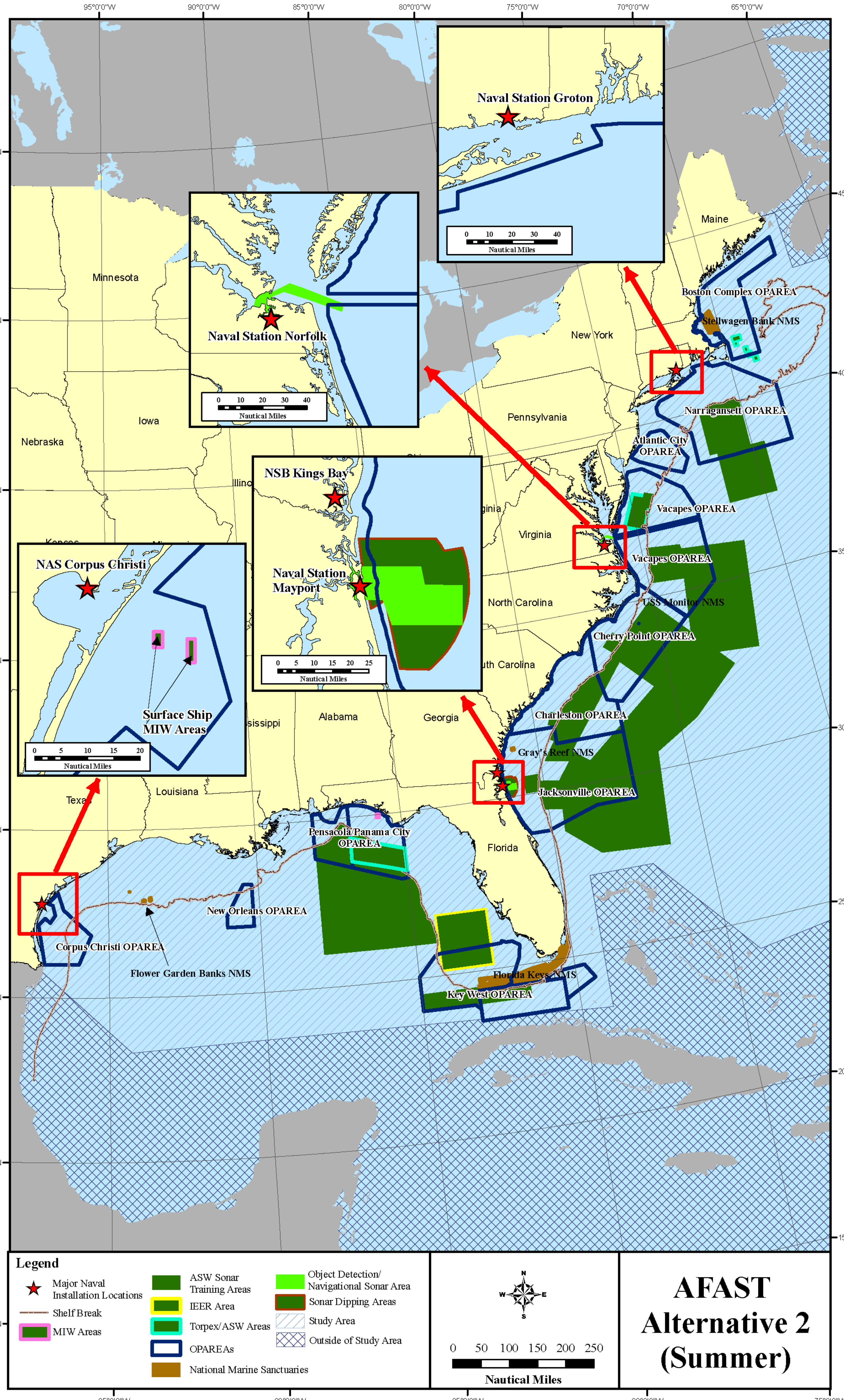


Figure ES-6. Alternative 2 – Active Sonar Activities would occur in Designated Areas (Overall–Summer)

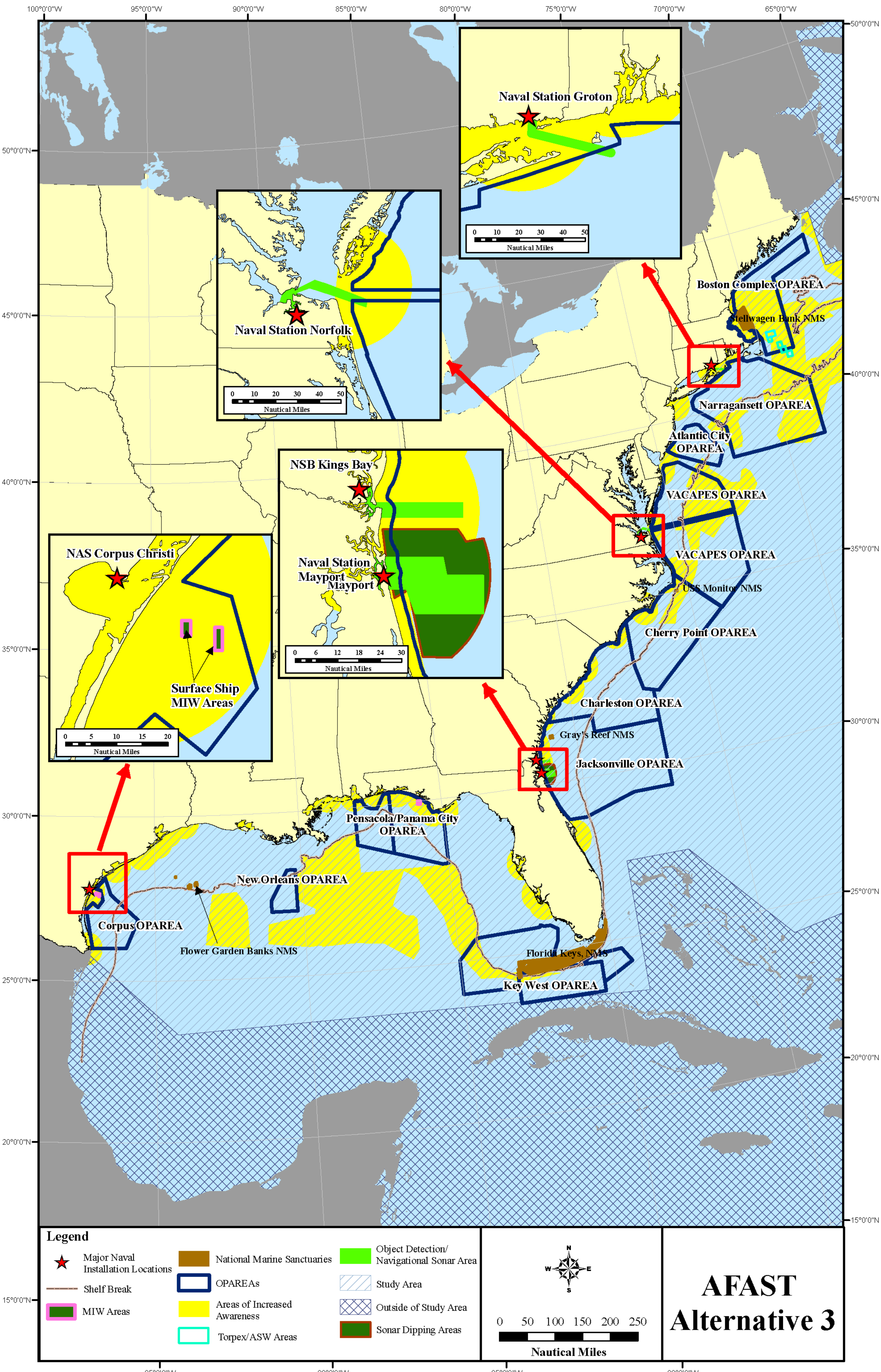


Figure ES-7. Alternative 3 – Active Sonar Activities would occur Outside of Areas of Increased Awareness (Overall)

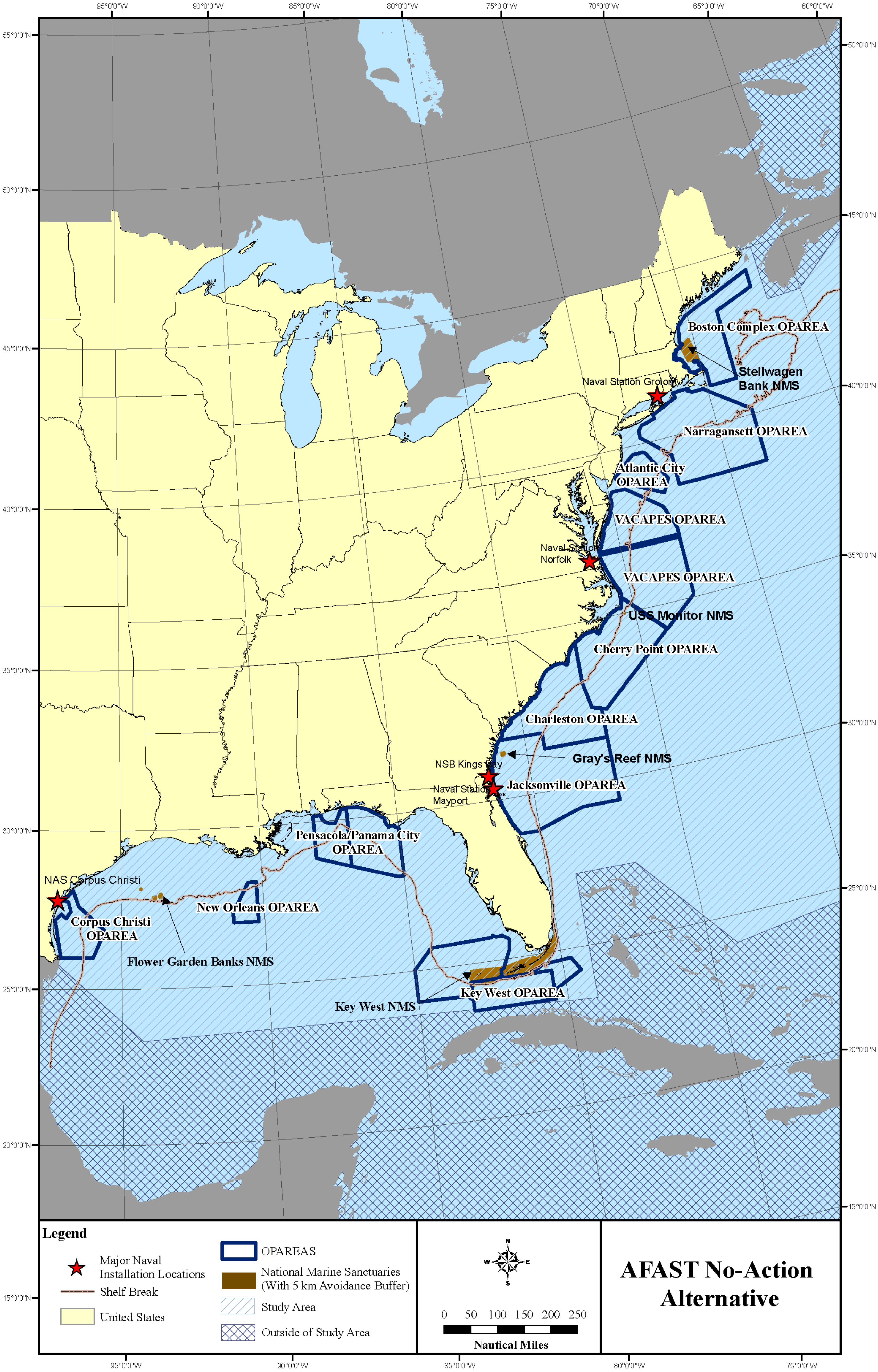


Figure ES-8. No Action Alternative – Active Sonar could occur Anywhere in the Study Area

This page is intentionally blank.

arise in the future. Limiting where naval forces can train will eliminate this critical option of training flexibility to respond to future crises.

Not only would Alternatives 1 and 2 severely limit the ability to train in areas similar to where potential threats operate, it would require the relocation of approximately 30 percent of Navy's current training. Furthermore, independent of the geographic limitations that would be imposed by Alternative 3; there is not a statistically significant difference in the analytical results (number of exposures) between Alternative 3 and the No Action Alternative. Because the difference in the acoustic effects analysis between Alternative 3 and the No Action Alternative is statistically insignificant, and the importance of the geographic flexibility required to conduct realistic training, the No Action Alternative was selected as the operationally preferred option.

ES.5 ALTERNATIVES ANALYSIS

Chapter 3 describes the existing environmental conditions for resources potentially affected by the Proposed Action and alternatives described in Chapter 2. Chapter 4 identifies and assesses the environmental consequences of the Proposed Action and alternatives. These environmental consequences are based on the possible effects of the Proposed Action: mid- and high frequency sound exposure, impulsive sound exposure, vessel strike, and expended materials (animal entanglement, sediment contamination, water quality reduction). The affected environment and environmental consequences are described and analyzed according to the environmental resource. The primary difference between alternatives is seen in the potential acoustic exposure numbers. Table ES-3 summarizes the potential acoustic exposure effects to marine mammals and sea turtles for each of the alternatives. Exposures numbers were rounded to "1" if the result was equal to or greater than 0.5. Even though an exposure number may have rounded to "0" in an individual analysis area, when summed with all other results for other analysis areas within the AFAST Study Area, an exposure of "1" is possible. Refer to Chapter 4 for more information. A summary of effects for all resources and alternatives is presented in Table ES-4.

This page is intentionally blank.

Table ES-3. Estimated Annual Marine Mammal and Sea Turtle Acoustic Exposures

	No Action Alternative				Alternative 1				Alternative 2				Alternative 3			
Species	**Mortality**	**PTS**	**TTS**	**Risk-Function**	**Mortality**	**PTS**	**TTS**	**Risk-Function**	**Mortality**	**PTS**	**TTS**	**Risk-Function**	**Mortality**	**PTS**	**TTS**	**Risk-Function**
Atlantic spotted dolphin	0	26	4143	372219	0	19	2583	252667	0	20	2612	255642	0	23	3745	338176
Atlantic white-sided dolphin	0	0	1	20640	0	0	0	46	0	0	0	46	0	0	1	20460
Bottlenose dolphin	0	47	6093	600710	0	26	3128	334839	0	29	3441	362145	0	41	5172	519664
Clymene dolphin	0	4	530	45909	0	4	493	43987	0	4	493	43987	0	4	531	46068
Common dolphin	0	5	861	95600	0	8	1137	171700	0	7	1045	163558	0	2	342	73558
False killer whale	0	0	7	487	0	0	7	481	0	0	7	481	0	0	7	480
Fraser's dolphin	0	0	5	341	0	0	5	337	0	0	5	337	0	0	5	335
Killer whale	0	0	1	62	0	0	1	62	0	0	1	62	0	0	1	61
Kogia spp.	0	0	44	4341	0	0	41	4332	0	0	41	4332	0	0	45	4379
Melon-headed whale	0	0	23	1619	0	0	23	1602	0	0	23	1602	0	0	23	1596
Pantropical spotted dolphin	0	12	1566	137739	0	13	1544	139878	0	13	1544	139878	0	12	1508	132774
Pilot whales**	0	10	1102	125155	0	8	833	92996	0	8	875	97124	0	10	1023	119958
Pygmy killer whale	0	0	3	233	0	0	3	230	0	0	3	230	0	0	3	229
Risso's dolphin	0	7	799	93275	0	5	519	64798	0	5	609	74364	0	7	799	91840
Rough-toothed dolphin	0	0	29	2679	0	0	29	2679	0	0	29	2679	0	0	22	2142
Short-finned pilot whale***	0	0	16	1120	0	0	16	1108	0	0	16	1108	0	0	16	1104
Sperm whale*	0	1	63	9694	0	0	45	6031	0	0	45	5922	0	0	45	8329
Spinner dolphin	0	2	289	20623	0	1	145	10472	0	1	145	10472	0	2	288	20580
Striped dolphin	0	10	908	173817	0	3	174	182586	0	3	179	182976	0	5	453	119540
White beaked dolphin	0	0	1	3449	0	0	1	3335	0	0	1	3335	0	0	1	3408
Beaked whale	0	0	35	4874	0	0	17	2096	0	0	15	1894	0	0	31	3404
Harbor porpoise	0	0	0	152370	0	0	0	28	0	0	0	28	0	0	0	152706
Bryde's whale	0	0	0	25	0	0	0	25	0	0	0	25	0	0	0	25
Fin whale*	0	0	1	870	0	0	1	465	0	0	1	465	0	0	1	709
Humpback whale*	0	0	29	4162	0	0	26	3934	0	0	26	3934	0	0	29	4112
Minke whale	0	0	2	413	0	0	2	219	0	0	2	219	0	0	2	476
North Atlantic right whale*	0	0	4	662	0	0	1	238	0	0	1	238	0	0	4	609
Sei whale*	0	0	0	1034	0	0	0	751	0	0	0	751	0	0	0	722
Gray Seal	0	0	31	7828	0	0	20	1434	0	0	20	1434	0	0	34	8406
Harbor Seal	0	0	29	12630	0	0	13	749	0	0	13	749	0	0	31	12667
Hardshell turtle*	0	0	2	N/A	0	1	4	N/A	0	1	3	N/A	0	1	2	N/A
Kemp's Ridley turtle[1]*	0	0	0	N/A	0	0	0	N/A	0	0	0	N/A	0	0	0	N/A
Leatherback turtle*	0	0	0	N/A	0	1	3	N/A	0	0	2	N/A	0	0	0	N/A
Loggerhead turtle*	0	1	3	N/A	0	1	5	N/A	0	1	5	N/A	0	1	3	N/A

N/A – Not applicable (criteria applies to active sonar only) ; PTS – permanent threshold shift (refer to Section 4.4.5.1); TTS – temporary threshold shift (refer to Section 4.4.5.1)
* Endangered or threatened species.
**Pilot whales include both short- and long-finned pilot whales along the East Coast.
***Reflects short-finned pilot whales in the Gulf of Mexico.
1. This category does not include Kemp's ridley sea turtles in the Gulf of Mexico. They are included in the hardshell sea turtle class.

This page is intentionally blank.

Table ES-4. Summary of Effects

Environmental Resource	All Alternatives
Sediment Quality	There would be no significant impact and no significant harm to sediment quality from expended components.
Marine Habitat	There would be no significant impact and no significant harm to marine habitat from expended components.
Water Quality	There would be no significant impact and no significant harm to water quality from expended components.
Marine Mammals	There would be no significant impact and no significant harm to marine mammals from expended components or vessel strikes. Refer to Table ES-3 for potential exposures to marine mammals from active sonar and explosive source sonobuoys (AN/SSQ-110A).
Sea Turtles	There would be no significant impact and no significant harm to sea turtles from expended components. There would be no significant impact and no significant harm to sea turtles from active sonar. Refer to Table ES-3 for potential exposures to impulsive sound from explosive source sonobuoys (AN/SSQ-110A).
Marine Fish	There would be no significant impact and no significant harm to fish from active sonar or explosive source sonobuoys (AN/SSQ-110A).
Essential Fish Habitat	There would be no effect to essential fish habitat from active sonar. There would be no significant impact and no significant harm to essential fish habitat from explosive source sonobuoys (AN/SSQ-110A).
Seabirds	There would be no significant impact and no significant harm to seabirds from active sonar, explosive source sonobuoys (AN/SSQ-110A), or entanglement associated with expended materials.
Marine Invertebrates	There would be no effect to marine invertebrates from active sonar or explosive source sonobuoys (AN/SSQ-110A).
Marine Plants and Algae	There would be no significant impact and no significant harm to marine plants and algae from active sonar or explosive source sonobuoys (AN/SSQ-110A).
National Marine Sanctuaries	There would be no significant impact and no significant harm to the Monitor, Gray's Reef, Florida Keys, Flower Garden Banks, or Stellwagen Bank NMS.
Airspace Management	There would be no effect to airspace management from activities involving active sonar or explosive source sonobuoys (AN/SSQ-110A).
Energy (Water, Wind, Oil, and Gas)	There would be no significant impact and no significant harm to energy exploration from activities involving active sonar or explosive source sonobuoys (AN/SSQ-110A).
Recreational Boating	There would be no significant impact and no significant harm to recreational boating from activities involving active sonar or explosive source sonobuoys (AN/SSQ-110A).
Commercial and Recreational Fishing	There would be no significant impact and no significant harm to commercial and recreational fishing from activities involving active sonar or explosive source sonobuoys (AN/SSQ-110A).
Commercial Shipping	There would be no significant impact and no significant harm to commercial shipping from activities involving active sonar or explosive source sonobuoys (AN/SSQ-110A).
Scuba Diving	There would be no significant impact and no significant harm to scuba diving from activities involving active sonar or explosive source sonobuoys (AN/SSQ-110A).
Marine Mammal Watching	There would be no significant impact and no significant harm to marine mammal watching from activities involving active sonar or explosive source sonobuoys (AN/SSQ-110A).
Cultural Resources	There would be no significant impact and no significant harm to cultural resources from activities involving active sonar or explosive source sonobuoys (AN/SSQ-110A).
Coastal Zone Consistency	Consistency Determinations have been submitted to the states of Connecticut, Florida, Georgia, Texas, and Virginia pursuant to 15 CFR Section 930.39.
Environmental Justice and Risks to Children	There would be no disproportionate effects to minority or low-income populations, and no environmental health risks or safety risks to children.

The Marine Mammal Protection Act (MMPA) (16 U.S.C. 1361 *et seq*) established, with limited exceptions, a moratorium on the "taking" of marine mammals in waters or on lands under U.S. jurisdiction (MMPA, 1972). The act further regulates "takes" of marine mammals on the high seas by vessels or persons under U.S. jurisdiction. The term "take," as defined in Section 3 of the MMPA (16 U.S.C. 1362), means "to harass, hunt, capture, or kill, or attempt to harass, hunt, capture, or kill any marine mammal." "Harassment" was further defined in the 1994 amendments to the MMPA, which provided two levels of harassment, Level A (potential injury) and Level B (potential disturbance).

Section 101(a)(5) of the MMPA directs the Secretary of Commerce to allow, upon request, the incidental, but not intentional, taking of marine mammals by U.S. citizens who engage in a specified activity (exclusive of commercial fishing). These incidental takes are allowed only if the National Oceanic and Atmospheric Administration's National Marine Fisheries Service (NMFS) issues regulations governing the permissible methods of taking. In order to issue regulations, NMFS must make a determination that (1) the taking will have a negligible impact on the species or stock, and (2) the taking will not have an unmitigable adverse impact on the availability of such species or stock for taking for subsistence uses.

In support of the Proposed Action, the Navy submitted an application requesting a Letter of Authorization (LOA) pursuant to Section 101(a)(5)(A) of the MMPA. After the application was reviewed by NMFS, a Notice of Receipt of Application was published in the *Federal Register* on March 5, 2008 (NMFS, 2008c). Publication of the Notice of Receipt of Application initiated the 30-day public comment period, during which time anyone could obtain a copy of the application by contacting NMFS. In addition, NMFS developed regulations governing the issuance of a LOA and published a Proposed Rule in the *Federal Register* on October 14, 2008 (NMFS, 2008f). Specifically, the regulations, when finalized, will establish (1) permissible methods of taking, and other means of affecting the least practicable adverse impact on such species or stock and its habitat, and on the availability of such species or stock for subsistence, and (2) requirements for monitoring and reporting of such taking. For military readiness activities (as described in the National Defense Authorization Act), a determination of "least practicable adverse impacts" on a species or stock that includes consideration, in consultation with the DoD, of personnel safety, practicality of implementation, and impact on the effectiveness of the military readiness activity.

The Endangered Species Act (ESA) (16 U.S.C. 1531 to 1543) applies to federal actions in two separate respects. First, the ESA requires that federal agencies, in consultation with the responsible wildlife agency (e.g., NMFS), ensure that proposed actions are not likely to jeopardize the continued existence of any endangered species or threatened species, or result in the destruction or adverse modification of a critical habitat (16 U.S.C. 1536 [a][2]). Regulations implementing the ESA expand the consultation requirement to include those actions that "may affect" a listed species or adversely modify critical habitat. Second, if an agency's proposed action would take a listed species, the agency must obtain an incidental take statement from the responsible wildlife agency. The ESA defines the term "take" to mean "harass, harm, pursue, hunt, shoot, wound, kill, trap, capture, or collect, or attempt any such conduct" (16 U.S.C. 1532[19]). As part of the environmental documentation for this EIS/OEIS, the Navy entered into early consultation with NMFS (Appendix A, Agency Correspondence). Consultation will be considered complete once NMFS prepares a final Biological Opinion and issues an incidental take statement.

ES.6 MITIGATION MEASURES

NEPA regulations require an EIS to include appropriate mitigation measures not already present in the Proposed Action or alternatives (40 CFR 1502.14[f]). Each of the alternatives and the Proposed Action considered in this EIS/OEIS, include mitigation measures intended to reduce environmental effects from Navy activities. Acoustic effects already presented assume no mitigation measures; therefore, effects would be lessened by implementation of these measures. These measures are detailed in Chapter 5, Mitigation Measures.

ES.7 CUMULATIVE IMPACTS

The approach taken in the analysis of cumulative impacts achieves the objectives of NEPA. CEQ regulations (40 CFR 1500 to 1508), which provide the implementing procedures for NEPA, define *cumulative impacts* as the impact on the environment which results from the incremental impact of the action when added to other past, present, and reasonably foreseeable future actions regardless of what agency (federal or non-federal) or person undertakes such other actions (40 CFR 1508.7).

All resources analyzed in Chapter 4 were carried forward into the cumulative impacts analysis for the purpose of determining whether the Proposed Action would have an incremental impact when combined with other past, present, and reasonably foreseeable actions. These projects are described in Chapter 6, Cumulative Impacts, and are considered on a resource-specific basis in the cumulative impacts analysis. It was determined that active sonar activities would not contribute to a significant incremental cumulative impact on these resources when combined with other past, present, and reasonably foreseeable activities.

ES.8 DIFFERENCE IN EXPOSURE ESTIMATES BETWEEN THE AFAST DRAFT EIS/OEIS AND AFAST FINAL EIS/OEIS

During the review process of the AFAST Draft EIS/OEIS, two calculation errors were discovered in the acoustic effects analysis. These errors are primarily attributed to the use of incorrect density estimates far offshore (and far outside of typical habitat) for harbor porpoises and pinnipeds (gray and harbor Seals), as well as modeling of in port submarine maintenance as a moving vice stationary source, which resulted in an artificial inflation of the total number of exposures calculated in AFAST Draft EIS/OEIS. Using the corrected method, the number of exposures calculated in the AFAST Final EIS/OEIS (as depicted in Table ES-3) are lower than the comparable Table ES-3 in the AFAST Draft EIS/OEIS. This reduction in the number of exposures calculated was solely due to the correction of the calculation errors discovered, and is not due to any alterations to the proposed action or alternatives in the AFAST Final EIS/OEIS.

This page is intentionally blank.

1. PURPOSE AND NEED FOR THE PROPOSED ACTION

The Department of the Navy (DON) has prepared this Atlantic Fleet Active Sonar Training (AFAST) Environmental Impact Statement/Overseas Environmental Impact Statement (EIS/OEIS) to analyze the potential environmental effects associated with the use of mid- and high-frequency active sonar technology and the improved extended echo ranging (IEER) system during Atlantic Fleet training exercises. The IEER system consists of an explosive source sonobuoy (AN/SSQ-110A) and an air deployable active receiver (ADAR) sonobuoy (AN/SSQ-101). The Navy is developing the Advanced Extended Echo Ranging (AEER) system as a replacement to the IEER system. The AEER system would use a new active sonobuoy (AN/SSQ-125) that utilizes a tonal (or a ping) versus an impulsive (or explosive) sound source as a replacement for the AN/SSQ-110A. The AEER system will still use the ADAR sonobuoy as the systems receiver. In addition, this document incorporates research, development, test, and evaluation (RDT&E) active sonar activities similar, and coincident with, Atlantic Fleet training. For the purposes of this document, "active sonar activities" refers to training, maintenance, and RDT&E activities involving mid- and high-frequency active sonar and explosive source sonobuoy (AN/SSQ-110A). Refer to Figure 1-1 for terminology used throughout this document.

The Navy's Proposed Action is to designate areas where mid- and high-frequency active sonar and IEER system training, maintenance, and RDT&E activities will occur within and adjacent to existing operating areas (OPAREAs) and to conduct these activities. These areas are located along the East Coast of the United States (U.S.) and within the Gulf of Mexico (Figure 1-2). Navy OPAREAs include designated ocean areas near fleet concentration areas (i.e., homeports). OPAREAs are where the majority of routine Navy training and RDT&E takes place (DON, 2004a). Active sonar activities are not confined to the OPAREAs. Some training exercises or portions of exercises are conducted seaward of the OPAREAs and a limited amount of active sonar use is conducted shoreward of the OPAREAs.

- **Sonar**-A method that uses sound waves to detect objects. An acronym derived from **So**und **Na**vigation and **R**anging.
- **Passive Sonar-**An instrument that listens to incoming sounds without needing to emit sound energy into the water.
- **Active Sonar-**An instrument that emits acoustic energy into the water to obtain information from the reflected sound energy.
- **Low Frequency Active Sonar**-An instrument that emits acoustic energy with a frequency less than 1 kilohertz (kHz).
- **Mid-Frequency Active Sonar**-An instrument that emits acoustic energy with a frequency ranging from 1 to 10 kHz.
- **High Frequency Active Sonar**-An instrument that emits acoustic energy with a frequency greater than 10 kHz.
- **Explosive source sonobuoy (AN/SSQ-110A) -** A remotely commanded, air-dropped, explosive sonobuoy.

Figure 1-1. Select Sound Terminology

Surface ships, submarines, helicopters and maritime patrol aircraft (MPA) utilize active sonar during Anti-Submarine Warfare (ASW), Mine Warfare (MIW), object detection/navigational training exercises, and during active sonar system maintenance activities.

The activities involving active sonar described in this EIS/OEIS are not new and do not involve significant changes in systems, tempo, or intensity from past activities. The activities analyzed in this document include Independent Unit Level Training (ULT) activities, Coordinated ULT activities, Strike Group training exercises, RDT&E activities, and active sonar maintenance. (Individual ships, submarines and aircraft are referred to as units.) Active sonar activities are discussed in Chapter 2.

1.1 PURPOSE

The purpose of the Proposed Action is to provide mid- and high-frequency active sonar and IEER training for U.S. Navy Atlantic Fleet ship, submarine, and aircraft crews, to support the requirements of the Fleet Response Training Plan (FRTP) and stay proficient in ASW and MIW skills. In addition, the EIS/OEIS incorporates research, development, test, and evaluation (RDT&E) active sonar activities similar, and coincident to, Atlantic Fleet training that have not been previously evaluated in other environmental planning documents. The FRTP is the Navy's training plan that requires naval forces to develop warfare skills in preparation for operational deployment and to maintain a high level of proficiency and readiness while deployed. The FRTP fulfills United States Code (U.S.C.) Title 10 requirements.

1.2 NEED

The Navy's need for training and RDT&E is found in Title 10 of the U.S.C., Section 5062 (10 U.S.C. 5062). This statute requires the Navy to be "organized, trained, and equipped primarily for prompt and sustained combat incident to operations at sea." The current and emerging training, maintenance, and RDT&E activities addressed in this EIS/OEIS are conducted in fulfillment of this legal requirement.

1.3 WHY THE NAVY TRAINS

"It cannot be too often repeated that in modern war, and especially in modern naval war, the chief factor in achieving triumph is what has been done in the way of thorough preparation and training before the beginning of war."

President Theodore Roosevelt, 1902

Training refers to the acquisition of knowledge, skills, and competencies as a result of the teaching of vocational or practical skills, and knowledge that relates to specific useful skills. In the military context, it means gaining the physical skills, ability, and knowledge to perform and survive in combat. It includes basic military, skill-specific, and weapons-specific training (both hardware and tactical), as well as formal education. It builds proficiency, cohesion, and teamwork and is fundamental to achieving unity of effort. Training is the primary means for establishing, maintaining, and improving the naval forces readiness to fight and win.

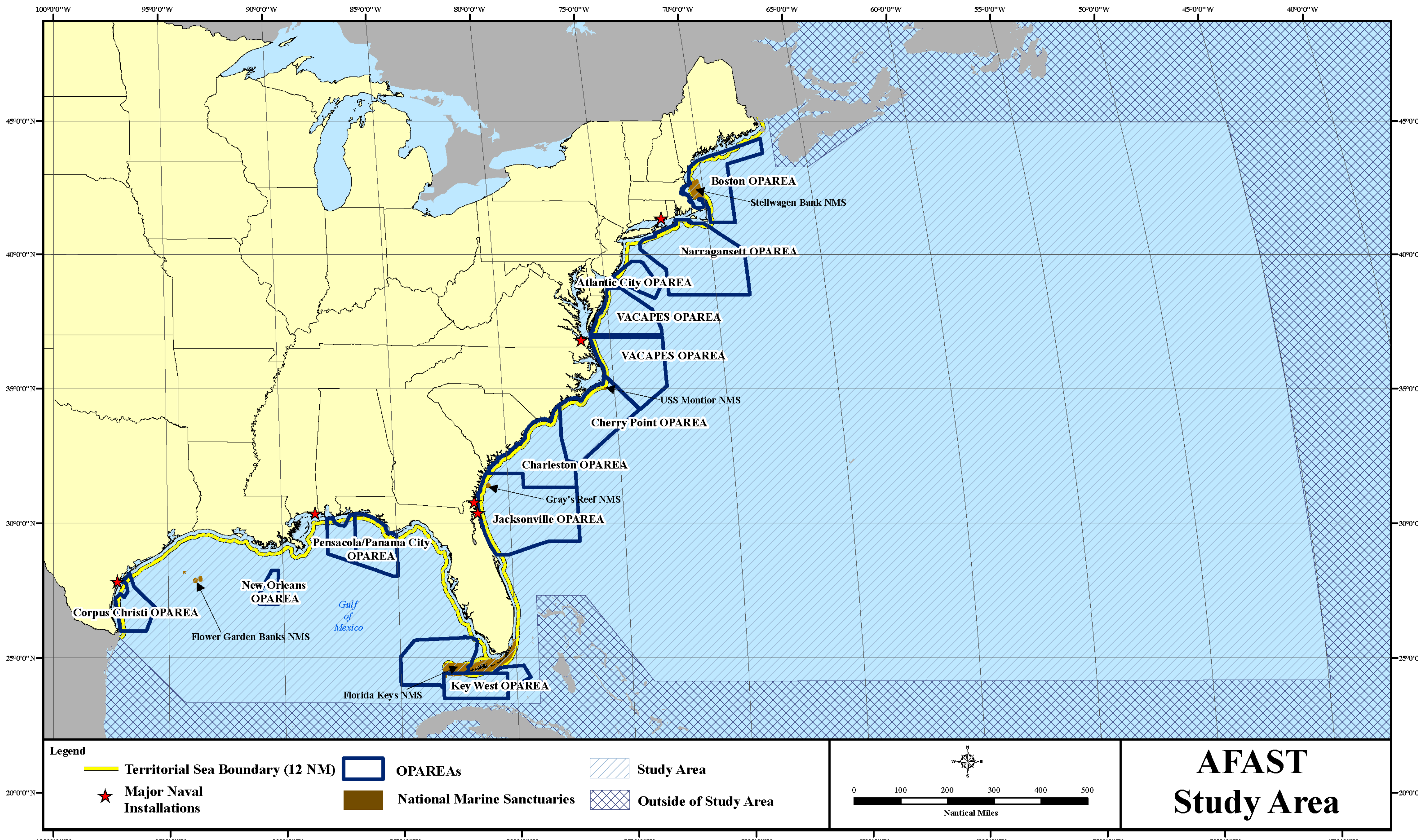


Figure 1-2. Overall Atlantic Fleet Study Area

This page is intentionally blank.

1.3.1 Our Navy Mission

The United States military is maintained to ensure the freedom and safety of all Americans both at home and abroad. In order to do so, Title 10 of the U.S.C. requires the Navy to "maintain, train and equip combat-ready naval forces capable of winning wars, deterring aggression and maintaining freedom of the seas." Every day, American Sailors and Marines courageously endure danger and hardships to protect our constitutional rights. How well we accomplish this mission depends on how thoroughly we maintain our nation's military readiness, today and into the future.

1.3.2 How We Fight

The key to combat effectiveness is realistic training in the air, on land, and at sea. So "Train As We Fight" is not just a phrase, but rather a statement that captures the absolute necessity to realistically train our Sailors and Marines for the conditions in which they may find themselves while protecting the nation's interest.

1.3.3 Train As We Fight - The Requirement For Realistic Training

Realistic training prepares for and supplements combat experience. Combat is a time of intense chaos where stress and confusion can easily overcome self-discipline and focus. Military commanders throughout the ages have relied on intensive and repetitive training to engrain combat skill. They understand that when confronted with danger, humans will respond in the way most familiar to them. Training "as we intend to fight" means realistic exercises which replicate the stress, discomfort, and physical conditions of combat. A realistic training program is essential to preparing our forces and generating confidence in, and knowledge of, our plans, tactics, and procedures. This begins with basic unit level training and builds incrementally to large-scale free-play exercises. This training involves all elements of naval forces, which prepares Sailors and Marines to safely and successfully complete their real world missions. In other words, we train as if full-scale armed conflict were imminent. Whether conducting training or engaged in combat, the same organizational structure, procedures, command and control, equipment, and thinking apply.

From a historical perspective, there is a direct relationship between realistic, demanding training and U.S. combat effectiveness and personal survival. For example, data from World Wars I and II indicates that aviators who survive their first five combat engagements are likely to survive the war. Additionally, the ratio of enemy aircraft shot down by U.S. aircraft in Vietnam improved from less than 1-to-1 to 13-to-1 after the Navy established its Fighter Weapons School, popularly known as TOPGUN. This dramatic improvement is directly attributable to extensive, realistic, combat-like training. In operations against Iraq between 1991 and 1993, United States Air Force airplanes shot down 39 airborne enemy aircraft, while Iraqi aircraft failed to shoot down any USAF aircraft. Experience from combat missions conducted during Operation Desert Fox and in the Balkans also demonstrates a strong statistical correlation between realistic training and combat success. Finally, jet bomber aircrews who receive realistic training in the delivery of precision-guided air-to-land munitions have twice the hit-to-miss ratio as those who do not receive such training. This results in trained aircrews requiring fewer sorties to accomplish assigned missions, which in turn, results in less risk to personnel and equipment and less chance of collateral damage to noncombatants or friendly forces.

The above examples provide a testament to the value of rigorous, realistic training. The statistics and observations clearly point out that when called upon, realistically trained Soldiers, Airmen and Sailors are more effective and efficient in conducting combat operations. The converse is also true, which means that reducing training realism results in higher casualties and lowered combat effectiveness. The simple fact is that the American military needs realistic training in order to fight and win America's wars. The goal of realistic training is to re-create as closely as possible those critical “first encounters” with the adversary to ensure the mission is completed and protect the lives of our service members.

Realistic training at sea is critical to ensure Sailors are capable of operating day and night, during all weather conditions, and in a wide variety of environments, from open ocean to near shore. The standard expected is further defined by the demands faced in the Fleet – the what, where, and how we are expected to fight. The U.S. Navy’s at-sea training range complexes and operating areas are where the learning takes place, the warfighting skills are honed, the “first encounters” are realistically re-created, and the mistakes are made without lethal results.

1.3.4 Where We Train – At Sea Range Complexes and Operating Areas

We rely on the full use of our at-sea range complexes, operating areas and adjacent areas to provide the combat-like experience that gives our forces a competitive advantage in war. These complexes and areas, individually and collectively, provide land, sea, and airspace where our naval forces can realistically train in a variety of conditions, while providing the ability to test and evaluate their capabilities. The areas of the ocean used for military training are crucial to sending our men and women into combat superbly prepared and confident in their abilities. The ocean’s inherent complex nature, whether in open ocean, in shallow coastal waters, or on a beach gives us the real-world platform to "train as we fight."

Range complexes provide a controlled and safe environment with threat representative conditions that enable our forces to conduct realistic combat-like training as they undergo all phases of the graduated buildup needed for combat ready deployment. Our ranges and operating areas provide the space necessary to conduct controlled and safe training scenarios representative of those that our men and women would have to face in actual combat. The range complexes are designed to provide the most realistic training in the most relevant environments, replicating to the best of our abilities the stresses we expect to endure. The integration of at-sea ranges, with land-based bombing ranges, safety landing fields and amphibious landing sites are critical to this realism, allowing real-time exercise play in complex scenarios. Live training, most of it accomplished in the waters off the nation’s East and West Coasts, will remain the cornerstone of readiness as we transform our military forces for a security environment characterized by uncertainty and surprise.

No amount of technology, hardware, or classroom education can achieve the required level of combat readiness without access to quality range complexes and operating areas that afford our naval forces the realistic training needed to execute their missions. Simulation and models play an important role, but have clear limits. There is no way to simulate the feeling of riding through the surf on a landing craft, experience just what the recoil of the main gun on an Abrams tank is like, or the intensity of searching for an elusive, ultra-quiet submarine.

1.3.5 Why We Train With Active Sonar

Our nation's capability to train its naval forces for combat cannot be taken for granted. Readiness is paramount. The ultimate objective of military readiness is to deter conflict when possible, win wars when necessary, and bring our troops home safely. This level of readiness is only effectively achieved through rigorous, realistic training. Realistic training forms the solid foundation of our credible combat capability, and no amount of technology, personnel, or classroom education can achieve this level of readiness without access to quality at sea training range complexes and operating areas to properly prepare our naval forces for the rigors of combat. The first time our naval forces conduct a realistic operation must not be during time of war. The results of such a policy can be seen throughout the history of armed conflict, and it has always been disastrous.

Sea control is the foundation for the United States' global power projection. If the U.S. cannot command the seas and airspace above them, we cannot project power to command or influence events ashore and we cannot shape the security environment. For the last century, submarines have been the weapon of choice for weaker naval powers intending on contesting a dominant power's control of the seas. Today, there are more than 300 modern, quiet diesel submarines around the world, operated by more than 40 nations, including Iran and North Korea. Our Nation must provide our Sailors and Marines the ability to defend themselves against this threat. The key to maintaining the Navy's ability to defend against adversary submarines is a comprehensive "at-sea" training regime to prepare our Sailors for this threat. This training requires the use of active sonar. The skills developed during this training are perishable and require periodic refreshing, which can't be regenerated easily. If training is not as realistic as possible, we will quickly lose our edge in this critical dimension of the battlefield.

Basic ASW and MIW combat skills are learned and practiced by units during FRTP basic phase training. (In this document, the basic phase training is described as Independent ULT, which involves one unit and Coordinated ULT, which involves more than one unit.) Strike Group Training is integrated training using progressively more difficult, complex, and large-scale exercises conducted at an increasing tempo. This training provides the warfighter with the skills necessary to function as part of a coordinated fighting force in a hostile environment with the capability to accomplish multiple missions. By conducting this training, the Navy satisfies its legal requirement to maintain, train, and equip combat-ready naval forces that are capable of winning wars, deterring aggression, and maintaining freedom of the seas.

Surface ships and submarines participating in the training must also conduct active sonar maintenance pier side and during transit to the training exercise location. Active sonar maintenance is required to ensure that the sonar system is operating properly before engaging in the training exercise or when the sonar systems are suspected of operating at levels below optimal performance.

Additionally, RDT&E provide the Navy the capability of developing new active sonar systems and ensuring their safe and effective implementation. The RDT&E sensors analyzed in this document are either existing systems or new systems with similar operating parameters to those used during Atlantic fleet training.

1.3.5.1 ASW Training

The ability to locate and track a submarine is a mission skill that must be possessed by every deploying strike group and individual ASW units. There are three fundamental truths about ASW. First, it is critically important to sea control, power projection, and direct support to land campaigns. As the United States looks to maintain its forward presence and power projection from the sea, hostile submarines pose a direct threat that denies, frustrates, or delays sea-based operations. We must retain the capability to defend against this threat.

Second, ASW requires a highly competent team of air, surface and sub-surface platforms to be effective in a complex and a highly variable three-dimensional environment. Each of our assets brings different strengths to the fight. We will need this full spectrum of undersea, surface, airborne, and space-based systems to ensure that we fully exploit the operating area. The undersea environment – ranging from the shallows to the vast deeps of the great ocean basins and polar regions under ice – demand a multi-disciplinary approach: reliable intelligence; oceanography; and surveillance and cueing of multiple sensors, platforms and undersea weapons. Most importantly, it takes highly skilled and motivated people.

Third, ASW is extremely difficult. During the 1982 Falklands conflict, the Argentine submarine SAN LUIS operated in the vicinity of the British task force for more than a month and was a constant concern to Royal Navy commanders. Despite the deployment of five nuclear attack submarines, 24-hour per day airborne ASW operations, and expenditures of precious time, energy, and ordinance, the British never detected the Argentine submarine. The United States must effectively employ all its capabilities to find modern diesel, air-independent propulsion, and nuclear submarines in the noisy, contact-dense environments typical of the littoral and be ready as well to detect, neutralize, and engage submarines in deep water and arctic environments. Today, this complex and challenging mission taxes our forces to their very limits.

Potential adversary nations are investing heavily in submarine technology, including designs for nuclear attack submarines, strategic ballistic missile submarines, and modern diesel electric submarines. The modern diesel electric submarine is the most cost-effective platform for the delivery of several types of weapons, including torpedoes, long-range anti-ship cruise missiles, land attack missiles, and a variety of anti-ship mines. Since submarines are inherently covert and can operate independently of escort vessels, submarines conduct intrusive operations in sensitive areas and can be inserted early in a mission without being detected. The inability to detect a hostile submarine before it can launch a missile or a torpedo is a critical vulnerability that puts U.S. forces and merchant mariners at risk and, ultimately, threatens U.S. national security.

Since Navy personnel ultimately fight as trained, a training environment that matches the conditions of actual combat is necessary. Sailors must also train using the combat tools that would be used during a conflict. A complicating factor facing the Navy today is the nature of the littoral waters where submarines can operate. These littoral regions are frequently confined, congested water and associated air space, which makes identification of allies, adversaries, and neutral parties more challenging than in open ocean. Essentially, effective use of Active Sonar involves as much skill as science, and the skill is perishable, necessitating access to real world training environments on a recurring basis.

When searching for submarines, U.S. naval forces use many sensors. The two broad categories of sensors in use today are acoustic (sound) and non-acoustic. Acoustic tools are currently more effective for searching for submarines because sound travels through water more easily than non-acoustic emissions like light and radio waves. Two types of acoustic devices, passive and active sonar, can be used to detect submarines. Passive sonar involves listening for any sounds inadvertently emitted by a potentially hostile submarine, which are then used to detect, localize, and track it. As a result, modern, quiet submarines have been designed to be quieter through the use of improved technology and to "hide" in the naturally occurring noise levels of the shallow waters of coastal environments. The result is that a modern, quiet submarine operating on battery power is nearly undetectable to naval forces using only passive sonar. Accordingly, sonar, which was initially developed during World War I, has been improved and deployed on U.S. naval vessels since the mid-1920s. Therefore, continue training and use of active sonar systems is vital since these submarines are designed to suppress emitted noise levels specifically to counter and defeat passive sonar technology. Active sonar devices emit sound energy into the water and receive it after it bounces off the hulls of threat submarines (Figure 1-3). Modern, quiet submarines can be better detected using active sonar and IEER devices, which can detect threat submarines at distances outside the firing range of many modern-day torpedoes (Figure 1-4). Although the navy continues evaluating technologies to locate and track submarines, active sonar remains the most viable means of locating and tracking submarines.

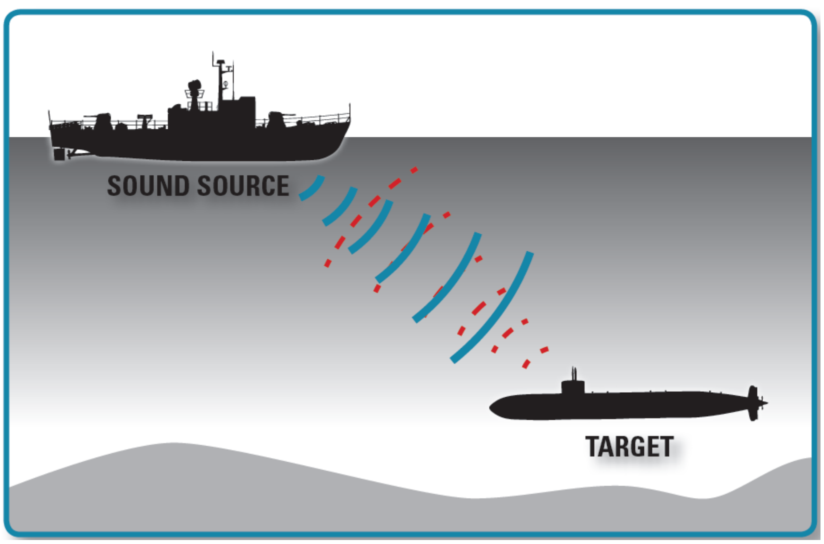


Figure 1-3. Depiction of Surface Ship Using Active Sonar

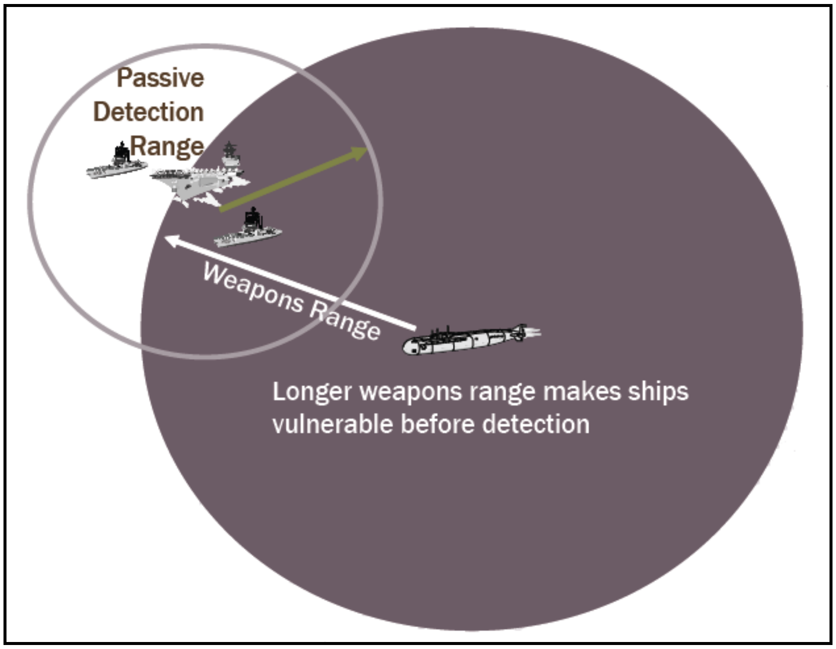


Figure 1-4. Depiction of Passive Detection Range and Submarine Weapons Range

ASW remains the linchpin of sea control. With the proliferation of modern, quiet submarines and the expansion of the Navy mission to both littoral and deep waters, the ASW challenge has become more severe. To counter the adversarial submarine challenges, the Navy's best course of action is to conduct extensive integrated training including the use of active sonar in areas that mirror the intricate operating environment present in hostile waters.

1.3.5.2 MIW Training

The use of naval mines is one of the simplest ways for enemies to damage ships and disrupt shipping lanes. Over the past 60 years, at least 14 U.S. ships have been damaged or sunk by mines as a result of relatively small-scale mining operations (Figure 1-5). Since more than 90 percent of military equipment used in international operations travels by sea, mines have the potential to either delay land and sea military operations by denying access to shallow-water areas, or prevent the delivery of military equipment altogether.

Today, the Navy can expect to encounter a wide spectrum of naval mines, from traditional, low-technology mines, to technologically advanced systems. For instance, mines can have irregular shapes, sound-absorbent coatings, and nonmagnetic material composition, each of which increase their resistance to countermeasures and reduce their maintenance requirements.

Figure 1-5. Depiction of Ship with Mine Damage

This means that mines can stay active in the water longer, are harder to find and are more difficult to neutralize (disarm with the use of countermeasures). More advanced mines are designed with remote controls, improved sensors, and counter-countermeasures that further complicate efforts to identify, classify, and neutralize them. In addition to improved mine technology, the underwater acoustic conditions often present in shallow waters require the use of specialized technology to successfully detect, avoid, and neutralize mines (DON, 2006a).

Training on MIW sonar is crucial because mines are a proven and cost-effective technology that is continually improving to make them more lethal, reliable, and difficult to detect. Because mines do not emit sound, active (rather than passive) sonar technology provides the warfighter with the capability to quickly and accurately detect, classify, and neutralize mines in small, crowded, shallow-water environments. These MIW capabilities are essential to ensure the United States' maritime dominance and protect the Navy's ability to operate on both land and sea, including the delivery of military equipment.

1.4 REGULATORY COMPLIANCE

NEPA and Presidential Executive Order (EO) 12114, *Environmental Effects Abroad of Major Federal Actions* require an assessment of the Proposed Action's effects within and outside U.S. territory; therefore, this document is being prepared as a combined EIS/OEIS under the authorities of both. In Chapter 4 of this EIS/OEIS, italicized text describes the effects that occur in areas located within the U.S. territory, while non-italicized text describes the effects that occur in areas located outside the U.S. territory. In addition to NEPA and EO 12114, this document complies with a variety of other environmental laws, regulations, and Executive Orders, the most relevant of which are summarized in the following sections.

1.4.1 NEPA

In 1969, Congress enacted the National Environmental Policy Act (NEPA) (42 U.S.C. 4321 et seq.), which provides for the consideration of environmental issues in federal agency planning and decision making. Regulations for federal agency implementation of the act were established by the President's Council on Environmental Quality (CEQ). NEPA requires that federal agencies prepare an EIS for proposed actions with the potential to significantly affect the quality of human and natural environments. The EIS must disclose significant environmental impacts and inform decision makers and the public of the reasonable alternatives to the proposed action. Impacts to ocean areas of the AFAST Study Area that lie within 22.2 kilometers (km) (12 nautical miles [NM]) of land (territorial seas) are subject to analysis under NEPA. This is based on Presidential Proclamation 5928, issued December 27, 1988, in which the United States extended its exercise of sovereignty and jurisdiction under international law to 22.2 km (12 NM) from land, although the Proclamation expressly provides that it does not extend or otherwise alter existing federal law or any associated jurisdiction, rights, legal interests, or obligations.

1.4.2 EO 12114

EO 12114 directs federal agencies to provide for informed decision making for major federal actions outside the United States, including the global commons, the environment of a non-participating foreign nation, or effects on protected global resources. An OEIS is required when an action has the potential to significantly harm the environment of the global commons. "Global commons" are defined as "geographical areas that are outside of the jurisdiction of any nation, and include the oceans outside territorial limits (outside 22.2 km [12 NM] from the coast) and Antarctica. Global commons do not include contiguous zones and fisheries zones of foreign nations" (32 CFR 187.3). The Navy has published procedures for implementing EO 12114 in 32 CFR 187, Environmental Effects Abroad of Major Department of Defense Actions, as well as the October 2007 Office of the Chief of Naval Operations Instruction (OPNAVINST) 5090.1C.

Unlike NEPA, EO 12114 does not require a scoping process. However, the EIS and OEIS have been combined into one document, as permitted under NEPA and EO 12114, in order to reduce duplication. Therefore, the scoping requirements found in NEPA were implemented with respect to actions occurring seaward of U.S. territorial waters, and discussions regarding scoping requirements will reference the combined AFAST EIS/OEIS.

1.4.3 Marine Mammal Protection Act

The Marine Mammal Protection Act (MMPA) (16 U.S.C. 1361 *et seq*) established, with limited exceptions, a moratorium on the "taking" of marine mammals in waters or on lands under U.S. jurisdiction (MMPA, 1972). The act further regulates "takes" of marine mammals on the high seas by persons or vessels under the jurisdiction of the United States. The term "take," as defined in Section 3 of the MMPA (16 U.S.C. 1362), means "to harass, hunt, capture, or kill, or attempt to harass, hunt, capture, or kill any marine mammal." "Harassment" was further defined in the 1994 amendments to the MMPA, which provided two levels of harassment, Level A (potential injury) and Level B (potential disturbance).

The National Defense Authorization Act (NDAA) of Fiscal Year (FY) 2004 (Public Law [PL] 108-136) amended the definition of "harassment" as applied to military readiness activities. Military readiness activities, as defined in PL 107-314, Section 315(f), include "training and operations of the Armed Forces that relate to combat" and constitute "adequate and realistic testing of military equipment, vehicles, weapons, and sensors for proper operation and suitability for combat use." These two definitions apply to active sonar activities; as such, the amended definition of "harassment" as applied in this EIS/OEIS is any act that:

- Injures or has the significant potential to injure a marine mammal or marine mammal stock in the wild ("Level A harassment"), or
- Disturbs or is likely to disturb a marine mammal or marine mammal stock in the wild by causing disruption of natural behavioral patterns including, but not limited to, migration, surfacing, nursing, breeding, feeding, or sheltering to a point where such behavioral patterns are abandoned or significantly altered ("Level B harassment") (16 U.S.C. 1362 [18][B][i],[ii]).

Section 101(a)(5) of the MMPA directs the Secretary of Commerce to allow, upon request, the incidental, but not intentional, taking of marine mammals by U.S. citizens who engage in a specified activity (exclusive of commercial fishing). These incidental takes are allowed only if the National Oceanic and Atmospheric Administration's (NOAA's) National Marine Fisheries Service (NMFS) issues regulations governing the permissible methods of taking. In order to issue regulations, NMFS must make a determination that (1) the taking will have a negligible impact on the species or stock, and (2) the taking will not have an unmitigable adverse impact on the availability of such species or stock for taking for subsistence uses.

In support of the Proposed Action, the Navy submitted an application requesting a Letter of Authorization (LOA) pursuant to Section 101(a)(5)(A) of the MMPA. After the application was reviewed by NMFS, a Notice of Receipt of Application was published in the *Federal Register* (NMFS, 2008c). Publication of the Notice of Receipt of Application initiated a 30-day public comment period, during which time anyone could obtain a copy of the application by contacting NMFS. In addition, NMFS developed regulations governing the issuance of a LOA and to publish a Proposed Rule in the *Federal Register* on October 14, 2008 (NMFS, 2008f). Specifically, the regulations, when finalized, would establish the following for each allowed activity:

- Permissible methods of taking, and other means of affecting the least practicable adverse impact on such species or stock and its habitat, and on the availability of such species or stock for subsistence.
- Requirements for monitoring and reporting of such taking.
- For military readiness activities (as described in the NDAA), a determination of "least practicable adverse impacts" on a species or stock that includes consideration, in consultation with the DoD, of personnel safety, practicality of implementation, and impact on the effectiveness of the military readiness activity.

1.4.4 Endangered Species Act

The Endangered Species Act (ESA) (16 U.S.C. 1531 to 1543) applies to federal actions in two separate respects. First, the ESA requires that federal agencies, in consultation with the responsible wildlife agency (e.g., NMFS), ensure that proposed actions are not likely to jeopardize the continued existence of any endangered species or threatened species, or result in the destruction or adverse modification of a critical habitat (16 U.S.C. 1536 [a][2]). Regulations implementing the ESA expand the consultation requirement to include those actions that "may affect" a listed species or adversely modify critical habitat.

Second, if an agency's Proposed Action would take a listed species, the agency must obtain an incidental take statement from the responsible wildlife agency. The ESA defines the term "take" to mean "harass, harm, pursue, hunt, shoot, wound, kill, trap, capture, or collect, or attempt any such conduct" (16 U.S.C. 1532[19]).

As part of the environmental documentation for this EIS/OEIS, the Navy has entered into early consultation with NMFS (Appendix A, Agency Correspondence). Consultation will be considered complete once NMFS prepares a final Biological Opinion (BO) and issues an incidental take statement.

1.4.5 Magnuson-Stevens Fishery Conservation and Management Act

The Magnuson-Stevens Fishery Conservation and Management Act (MSA) (16 U.S.C. 1801 *et seq*), enacted to conserve and restore the nation's fisheries, includes a requirement for NMFS and regional fishery councils to describe and identify essential fish habitat (EFH) for all species that are federally managed. "EFH" is defined as those waters and the substrate necessary to fish for spawning, breeding, feeding, or growth to maturity. Under MSA, federal agencies must consult with the Secretary of Commerce regarding any activity or proposed activity authorized, funded, or undertaken by the agency that may adversely affect EFH. If adverse effects to EFH are foreseeable, the Navy will submit an EFH assessment to the appropriate NMFS regional office.

1.4.6 Coastal Zone Management Act

The Coastal Zone Management Act (CZMA) (16 U.S.C. 1451 *et seq*)provides assistance to states, in cooperation with federal and local agencies, for developing land and water use programs for their respective coastal zones. It is important to note that a state's coastal zone extends seaward to 5.6 km (3 NM), except for the Texas and Florida Gulf Coasts, where the coastal zone extends seaward to 16.7 km (9 NM).

The CZMA requires that any federal agency activity within or outside the coastal zone that affects any land use, or water use, or natural resource of the coastal zone, be carried out in a manner that, to the maximum extent practicable, is consistent with the enforceable policies of NOAA-approved state coastal management programs. Under the CZMA, the Navy must determine whether the Proposed Action will have reasonably foreseeable effects to state coastal zone uses or resources. If there are reasonably foreseeable effects, then the Navy must ensure, to the maximum extent practicable, that the activities are consistent with the enforceable policies of each respective state. Both direct and indirect effects are considered. Where required, a determination under the CZMA would be submitted to the applicable state(s') coastal zone management agency.

1.4.7 Migratory Bird Treaty Act

The Migratory Bird Treaty Act (MBTA) (16 U.S.C. 703 *et seq*) was enacted to ensure the protection of shared migratory bird resources. The MBTA prohibits the take, possession, import, export, transport, selling, purchase, barter, or offering for sale, purchase or barter, any migratory bird, their eggs, parts, and nests, except as authorized under a valid permit. The MBTA protects a total of 836 bird species, 58 of which are currently legally hunted as game birds. The U.S. Fish and Wildlife Service (USFWS) regulations authorize permits for takes of migratory birds for activities such as scientific research, education, and depredation control.

The USFWS published a final rule in the *Federal Register* (effective March 30, 2007) that directly amended 50 CFR 21, *Migratory Bird Permits*, to authorize takes resulting from otherwise lawful military readiness activities (USFWS, 2007). This rule does not authorize takes under ESA, and the USFWS retains the authority to withdraw or suspend the authorization for incidental takes occurring during military readiness activities under certain circumstances.

Under this rule, the Navy is still required under NEPA to consider the environmental effects of its actions and assess the adverse effects of military readiness activities on migratory birds. If it is determined the Proposed Action may result in a significant adverse effect on a population of a migratory bird species, the Navy will consult with the USFWS to develop and implement appropriate conservation measures to minimize or mitigate these effects. Conservation measures, as defined in 50 CFR 21.3, include project designs or mitigation activities that are reasonable from a scientific, technological, and economic standpoint and are necessary to avoid, minimize, or mitigate the take of migratory birds or other potentially adverse impacts. Furthermore, a significant adverse effect on a population is defined as an effect that could, within a reasonable period of time, diminish the capacity of a population of a migratory bird species to sustain itself at a biologically viable level.

1.4.8 National Marine Sanctuaries Act

The National Marine Sanctuaries Act (NMSA) prohibits the destruction of, loss of, or injury to any sanctuary resource managed under law or regulations, and any violation of the act, any regulations, or permits issued thereunder (16 U.S.C. 1436). In addition, Section 304(d) of the NMSA (16 U.S.C. 1434[d]) requires federal agencies to consult with the Secretary of Commerce, through NOAA, on federal agency actions, internal or external, to any national marine sanctuary that are likely to destroy, cause the loss of, or injure any sanctuary resource (for Stellwagen Bank National Marine Sanctuary, the threshold is “may” destroy, cause the loss of, or injure). Under Section 304(d), if NOAA determines that the action is likely to destroy, cause the loss of, or injure sanctuary resources, NOAA shall recommend reasonable and prudent alternatives that can be taken by a federal agency to protect sanctuary resources. The federal agency may choose not to follow these alternatives provided the reasons are submitted in writing. However, if the head of a federal agency takes an action other than an alternative recommended by NOAA and such action results in the destruction of, loss of, or injury to a sanctuary resource, the head of the agency shall promptly prevent and mitigate further damage and restore or replace the sanctuary resource in a manner approved by NOAA. Regulations for each designated national marine sanctuary specifically address military and defense activities.

1.4.9 EO 13158, Marine Protected Areas

EO 13158 on Marine Protected Areas (MPAs) calls on the Department of Commerce and the Department of the Interior (DOI), in consultation with other federal agencies and stakeholders, to develop a national system of MPAs to enhance the conservation of the nation's natural and cultural marine heritage. The EO created the National Marine Protected Areas (NMPA) Center within NOAA to coordinate this effort. Currently, over 1,500 marine areas have been identified in the United States that are managed under the authority of hundreds of federal, state and territorial, tribal and local laws and regulations. Familiar examples of MPAs include national and state marine sanctuaries, parks, wildlife refuges, and some fishery management areas. A proposed draft framework for developing the MPA system was released in February 2007, which proposed guidelines for the development of the National System of MPAs. At this time, MPAs have not been formally designated under EO 13158.

1.4.10 EO 13089, Coral Reef Protection

In accordance with EO 13089 on Coral Protection (1998), all federal agencies whose actions may affect U.S. coral reef ecosystems shall: (1) identify their actions that may affect U.S. coral reef ecosystems; (2) utilize their programs and authorities to protect and enhance the conditions of such ecosystems; and (3) to the extent permitted by law, ensure that any actions they authorize, fund, or carry out will not degrade the conditions of such ecosystems.

1.5 COOPERATING AGENCIES

CEQ's NEPA implementing regulations allow federal agencies (as lead agencies) to invite tribal, state, and local governments, as well as other federal agencies, to serve as cooperating agencies in the preparation of EISs. The lead agency maintains the responsibility of supervising the development of the EIS, which addresses the potential effects associated with activities connected to the Proposed Action.

Upon request of the lead agency, any other federal agency that has jurisdiction can serve as a cooperating agency. In addition, any other federal agency with special expertise on any environmental issue that should be addressed in the EIS may serve as a cooperating agency upon request of the lead agency. The cooperating agency, upon request by the lead agency, is responsible for assisting in the development of information and preparing environmental analyses associated with the agency's area of expertise.

The Navy requested that NMFS participate as a cooperating agency in the preparation of this EIS/OEIS; NMFS has agreed to cooperating agency status (Appendix A, Agency Correspondence). NMFS is a cooperating agency primarily because of its responsibilities pursuant to Section 101(a)(5)(A) of the MMPA and Section 7 of the ESA.

1.6 PUBLIC INVOLVEMENT

The Navy initiated a mutual exchange of information through early and open communications with interested stakeholders during the development of this EIS/OEIS. A description of the public's involvement related to the preparation of the EIS/OEIS is presented in the following sections.

1.6.1 Notice of Intent

Under NEPA (42 U.S.C. 4321 et seq.), the EIS/OEIS must disclose significant environmental effects and inform decision makers and the public of the reasonable alternatives that would avoid adverse effects to, or minimize adverse effects to, or enhance the quality of the human environment. The first step in the NEPA process is publication of the notice of intent (NOI), which provides an overview of the proposed project and the scope of the EIS/OEIS. The NOI for the preparation of this EIS/OEIS was published in the *Federal Register* on September 29, 2006 (DON, 2006b).

1.6.2 Public Scoping Meetings

Scoping is an early and open process for determining the scope of the Proposed Action and the significant issues the EIS/OEIS must analyze in depth. During the scoping process, the public assists the Navy in defining and prioritizing issues through meaningful participation, including the submission of comments. The scoping period began with the publication of an NOI on September 29, 2006. Scoping letters were also sent to members of Congress; federal, state, and local agencies; and members of the general public.

As shown in Table 1-1, the Navy held eight scoping meetings during which naval staff and subject matter experts presented information using display boards and fact sheets in an open house format, as well as answered questions from attendees.

The scoping comment period lasted 78 days. The public scoping period was originally scheduled to close on December 1, 2006, but was extended 14 days to December 15, 2006 in order to host an eighth scoping meeting in New London, Connecticut, on November 29, 2006 (DON, 2006c). The public submitted comments at the scoping meetings and through fax, U.S. mail, and the AFAST EIS/OEIS website (i.e., http://afasteis.gcsaic.com). By December 16, 2006, agencies, organizations, and individuals had submitted 131 written and electronic comments. All scoping comments were reviewed, and applicable issues are addressed in this EIS/OEIS.

Table 1-1. Scoping Meeting Locations and Dates

Location	Date	Facility
Chesapeake, Virginia	October 23, 2006	Chesapeake Conference Center, 900 Greenbrier Circle
Corpus Christi, Texas	October 26, 2006	American Bank Center, 1901 North Shoreline Boulevard
New London, Connecticut	November 2, 2006	Radisson Hotel, 35 Governor Winthrop Boulevard
Jacksonville, Florida	November 7, 2006	Ramada Inn Mandarin, 3130 Hartley Road
Panama City, Florida	November 9, 2006	Marriot Bay Point Resort, 4200 Marriot Drive
Morehead City, North Carolina	November 14, 2006	National Guard Armory, 3609 Bridge Street
Charleston, South Carolina	November 16, 2006	Town and Country Inn (Conference Center), 2008 Savannah Highway
New London, Connecticut	November 29, 2006	Radisson Hotel, 35 Governor Winthrop Boulevard

1.6.3 Notice of Availability of the Draft EIS/OEIS

Following the public scoping process, the AFAST Draft EIS/OEIS was prepared to provide an assessment of the potential effects of the Proposed Action to the human or natural environment.

The document also informs decision makers and the public of reasonable alternatives that would avoid or minimize adverse effects or enhance the quality of the environment.

Upon release of the AFAST Draft EIS/OEIS, a notice of availability/notice of public hearings was published in the *Federal Register* on February 15, 2008 (DON, 2008a), as well as in 17 newspapers and on the project website. The document was then distributed to those individuals, agencies, and associations listed in Appendix B, Table B-1. In addition, notification of the availability of the AFAST Draft EIS/OEIS and public hearing schedule was sent to those individuals, agencies, and associations listed in Appendix B, Table B-2. In addition, the AFAST Draft EIS/OEIS was also made available for general review in 11 public libraries listed in Table B-1, as well as on the AFAST EIS/OEIS website. Public hearings were held following the release of the AFAST Draft EIS/OEIS to seek additional public comment on the document. The public review period ended on March 31, 2008.

1.6.4 Public Hearings Meetings

As shown in Table 1-2, the Navy held six public hearings during which naval staff and subject matter experts presented information using display boards and fact sheets in an open house format. Immediately following the open house, a formal presentation was held followed by an opportunity for the public to comment.

Table 1-2. Public Hearing Locations and Dates

Location	Date	Facility
Virginia Beach, Virginia	March 4, 2008	Tidewater Community College, Advanced Technology Center: Technology Theater, Faculty Drive
Boston, Massachusetts	March 6, 2008	Boston University, Kenmore Classroom Building, Room 101, 565 Commonwealth Avenue
Morehead City, North Carolina	March 11, 2008	Crystal Coast Civic Center, 3505 Arendall Street
Mount Pleasant, South Carolina	March 13, 2008	Charleston Harbor Resort and Marina, Atlantic Ballroom, 20 Patriots Point Road
Jacksonville, Florida	March 18, 2008	Florida Community College at Jacksonville, Nathan H. Wilson Center for the Arts: Lakeside Conference Room, 11901 Beach Boulevard
Panama City, Florida	March 19, 2008	Florida State University, Panama City Campus, Auditorium, 4750 Collegiate Drive

The entire public comment review period lasted 45 days, from the date the AFAST Draft EIS/OEIS was released on February 15, 2008, to March 31, 2008.. Comments were submitted at the public hearing meetings (written and oral), through fax, U.S. mail, and the AFAST EIS/OEIS website (i.e., http://afasteis.gcsaic.com). By the close of the comment period, a total of 214 agencies, organizations, and individuals had submitted 1,607 comments. This Final EIS/OEIS incorporates and formally responds to all substantive comments received on the Draft EIS/OEIS. Refer to Appendix J for additional information, including responses to comments.

1.6.5 Notification of Availability of the Final EIS/OEIS

The notice of availability of this Final EIS/OEIS was published in the *Federal Register*, in various newspapers, and on the project website. Release of the Final EIS/OEIS is accompanied by a 30-day wait period, unless otherwise approved by the Environmental Protection Agency (EPA). The EPA may, upon a showing by the lead agency of compelling reasons of national policy, reduce the prescribed periods and may, upon a showing by any other Federal agency of compelling reasons of national policy, also extend prescribed periods, but only after consultation with the lead agency.

1.6.6 Decision Document

A Record of Decision (ROD) will be issued no less than 30 days after the Final EIS/OEIS is made available and published in the *Federal Register* and local newspapers. The ROD will be a concise summary of the decision made by the Navy from the alternatives presented in the Final EIS/OEIS. Specifically, the ROD will state the decision, identify alternatives considered (including that which was environmentally preferable), and discuss other (non-environmental) considerations that influenced the decision identified. The ROD will also describe the implementation of practical measures intended to avoid effects from the chosen alternatives and explain any decision not to implement any of these measures. Once the ROD is published, public involvement is considered complete, and the Navy can implement the Proposed Action.

1.7 RELATED ENVIRONMENTAL DOCUMENTS

Compliance documents for some of the programs and projects related to the scope of this EIS/OEIS include the following:

1.7.1 Atlantic Fleet Tactical Training Theater Assessment and Planning Program EISs/OEISs

In 2002, Commander, U.S. Atlantic Fleet, and Commander, U.S. Pacific Fleet initiated the Tactical Training Theater Assessment and Planning (TAP) Program to serve as the overarching Fleet training area sustainment program.

TAP focuses specifically on the sustainability of ranges, OPAREAs, and special use airspace that support the FRTP. TAP represents the first time the Navy has managed its training areas on a range complex-wide basis. One element of TAP will be the development of Range Complex Management Plans and a companion document, the Navy Ranges Required Capabilities Document. Another TAP element is environmental planning documentation which will assess the potential for environmental effects associated with certain activities/actions conducted within a range complex. Specifically, the Navy is proposing to support and conduct current and emerging training operations and RDT&E operations in the range complexes by completing the following:

1. Achieving and maintaining Fleet readiness using the range complexes to support and conduct current, emerging, and future training operations and RDT&E operations,

2. Expanding warfare missions supported by the range complexes, and
3. Upgrading and modernizing existing range capabilities to enhance and sustain Navy training and RDT&E activities.

Where applicable, the results of this AFAST EIS/OEIS will be incorporated by reference into the environmental documentation for the following Atlantic Fleet range complexes:

- Northeast (Boston, Narragansett, and Atlantic City) Range Complex
- Virginia Capes (VACAPES) Range Complex
- Cherry Point (CHPT) Range Complex
- Jacksonville/Charleston (JAX/CHASN) Range Complex
- Gulf of Mexico (GOMEX) Range Complex
- Key West Range Complex

Although not directly related to this AFAST EIS/OEIS due to geographic separation, environmental documentation is also being prepared under the TAP Program for the following Pacific Fleet range complexes:

- Hawaii Range Complex
- Southern California Range Complex
- Northwest Training Range Complex
- Mariana Islands Range Complex

1.7.2 USWTR EIS/OEIS

The Navy released the Draft Undersea Warfare Training Range (USWTR) EIS/OEIS, which addresses a proposed action to instrument a 1,713 square kilometer (km^2) (an approximate 500 square nautical mile [NM^2]) area of the East Coast with undersea cables and sensor nodes, creating an undersea warfare training range, and to use the area for ASW training. Such training would typically involve up to three vessels and two aircraft using the range for any one training event. The instrumented area would be connected to the shore via a single trunk cable. The proposed action would require logistical support for ASW training, including the handling (launch and recovery) of exercise torpedoes (nonexplosive) and submarine target simulators. Active sonar hours proposed to be used during future USWTR are not analyzed in this AFAST EIS/OEIS. Cumulative impacts of a proposed USWTR are addressed in this AFAST EIS/OEIS (refer to Chapter 6).

1.7.3 Naval Surface Warfare Center, Panama City Division EIS/OEIS for RDT&E Activities

Naval Surface Warfare Center, Panama City Division (NSWC PCD) is currently in the process of developing an EIS/OEIS to address the effects associated with RDT&E activities related to littoral and expeditionary warfare activities proposed for the NSWC PCD Study Area in the northeastern Gulf of Mexico (DON, 2008j). These activities involve a variety of naval assets, including ships, aircraft, and underwater systems that support eight primary RDT&E capabilities: air, surface, and subsurface operations, sonar, laser, electromagnetic, live ordnance, and projectile firing operations occurring within the NSWC PCD Study Area. The potentially affected resources will be analyzed to evaluate if changes in NSWC PCD RDT&E activities, particularly sonar use and ordnance detonations, would affect the marine environment, air environment, and water surface environment. Active sonar hours proposed to be used during these RDT&E activities are not analyzed in this EIS/OEIS. Cumulative impacts from these RDT&E activities are addressed in this EIS/OEIS (refer to Chapter 6).

1.7.4 The Final Supplement to the Final Comprehensive Overseas Environmental Assessment for Major Atlantic Fleet Training Exercises

The December 2006 Final Supplemental Overseas Environmental Assessment (OEA) (DON, 2006d) documented a quantitative acoustic exposure effects analysis on marine mammals and sea turtles (Naval Surface Fire Support [NSFS] activities only) related to the proposed use of mid-frequency active sonar sources during 2007 Atlantic Fleet major training (Strike Group) exercises and from NSFS Integrated Maritime Portable Acoustic Scoring and Simulator (IMPASS) training that is ancillary to training exercises in accordance with EO 12114. Threshold criteria were used in the quantitative acoustic exposure effects analysis for both mid-frequency active sonar sources and for small ordnance used during NSFS (IMPASS) activities. Level B harassment was analyzed at 173 decibels (dB) based on the findings of Finneran and Schlundt (2004) after exposures were estimated at the 190 dB level. In addition to sonar, the Navy modeled NSFS explosive 5-inch rounds using the criteria for Level B harassment.

In cooperation with NMFS, a new scientific approach (risk-function) has been under development and is used in this EIS/OEIS to quantify the potential behavioral effects to marine mammals associated with active sonar use in Atlantic Fleet training activities. The current acoustic methodology used to quantitatively assess potential effects at the permanent threshold shift (PTS) and temporary threshold shift (TTS) levels has remained unchanged and is utilized in this EIS/OEIS. (PTS and TTS refer to a shift in the ability to detect sound within certain acoustic ranges due to a marine mammal's exposure to sound.) Active sonar use during Strike Group training exercises during the period of the LOA requested for AFAST (proposed December 2008 to 2013) are analyzed in this AFAST EIS/OEIS.

The 2008 Final Supplemental Overseas Environmental Assessment (DON, 2008b) analyzed the quantitative acoustic effects for mid-frequency active sonar training events that were scheduled as part of Atlantic Fleet training exercises over the course of one year beginning in Spring of 2008. This document supplements the environmental analysis contained in the Final Comprehensive Overseas Environmental Assessment for Major Atlantic Fleet Training Exercises(DON, 2006d), focusing on the potential environmental effects from mid-frequency active sonar utilized during Anti-submarine Warfare (ASW) training exercises during the 2008 Atlantic Fleet training exercises beginning in Spring 2008. In its BO, NMFS concluded that the anticipated behavioral takes were "not likely to result in jeopardy to the species." In addition, the proposed exercises "are not likely to result in destruction or adverse modification of critical habitat."

1.7.5 Final Biological Assessment for the United States Ship Truman 07-1 Combined Carrier Strike Group Composite Training Unit/Joint Task Force Exercise

The Navy prepared a Biological Assessment (BA) to address the use of mid-frequency active sonar during ASW training and the firing of 5-inch gun rounds (DON, 2006g). As previously mentioned, these activities occurred in July 2007 over a 30-day period. The exercises associated with the United States Ship (USS) Truman 07-1 Combined Carrier Strike Group Composite Training Unit/Joint Task Force Exercise (CSG COMPTUEX/JTFEX) occurred in the CHPT and JAX/CHASN OPAREAs. The Navy evaluated the potential acoustic effects related to mid-frequency active sonar and NSFS activities on ESA-listed marine mammals; the sea turtle analysis included only NSFS activities based on the species' hearing capabilities.

The Navy concluded that the USS Truman 07-1 Combined CSG COMPTUEX/JTFEX would not affect any of the ESA-listed fish or sea turtle species with exception of the loggerhead sea turtle. Additionally, the Navy concluded that there would be no effect to North Atlantic right whales, humpback whales, fin whales, or sei whales. The activities would not result in adverse modification or destruction to right whale designated habitat in the JAX/CHASN OPAREA. Finally, the Navy concluded that sperm whales and loggerhead sea turtles may be affected. The BA included a rigorous mitigation program (DON, 2006g). In its BO, NMFS concluded "the proposed action was not likely to jeopardize the continued existence of threatened or endangered species in the action area and would not likely destroy or adversely modify critical habitat" (NMFS, 2007h). The agency exempted the take of sperm whales and sea turtle species in the Incidental Take Statement (ITS) with implementation of the reasonable and prudent measures and terms and conditions (NMFS, 2007h).

1.7.6 ESA Section 7 Consultation on Navy Activities off the Southeastern United States along the Atlantic Coast

NMFS issued a BO in response to a BA sent by the Navy for training activities within and in the vicinity of the Atlantic Ocean right whale critical habitat off of the coasts of Georgia and Florida (NMFS, 1997). NMFS concluded in this BO that the Navy's actions presented in the BA may adversely affect, but were not likely to jeopardize the continued existence of, North Atlantic right whales and other ESA-listed species in the consultation area. In addition, NMFS determined Navy activities were not likely to result in the destruction or adverse modification of North Atlantic right whale critical habitat. The Navy has continued to conduct active sonar activities in a manner consistent with the May 1997 BO in the JAX/CHASN OPAREA. Mid-frequency active sonar methodology was not ripe for quantitative analysis during the issuance of this BO. Mid-frequency active sonar use will be addressed in the consultation accompanying this AFAST EIS/OEIS.

1.7.7 Northeast Torpedo Exercise Endangered Species Act Consultations

There are three documents addressing the testing of non-explosive torpedoes in the Atlantic Ocean: Programmatic OEA for MK-46, MK-54, and MK-48 Torpedo Exercises in waters off Cape Cod, Massachusetts (DON, 2007e), Concurrence on Torpedo Exercises Proposed in the Cape Cod Operating Area between August and December 2007 and 2008 are Not Likely to Adversely Affect Endangered or Threatened Species under NMFS' Jurisdiction (NMFS, 2007a), and Record of Negative Decision for Proposed Torpedo Exercises off Cape Cod, Massachusetts, 2007 to 2008 (DON, 2007g). The data from these analyses concluded that when mitigation measures are implemented, torpedo exercise activities would not significantly affect the environment, would not likely adversely affect threatened or endangered species under NMFS' jurisdiction, or result in the adverse modification or destruction of the North Atlantic right whale critical habitat.

1.7.8 Sinking Exercises in the Western North Atlantic Ocean Biological Opinion and Overseas Environmental Assessment

The Programmatic Overseas Environmental Assessment for Sinking Exercises in the Western North Atlantic (SINKEX) OEA (DON, 2006e) and BO (NMFS, 2006i) address mid-Atlantic vessel transit mitigation measures. These measures are included as part of the mitigation measures included in this AFAST EIS/OEIS (see Chapter 5). In the OEA and BO, the Navy proposed conducting SINKEX activities to train naval forces in the use of live weapons against a representative target. During a SINKEX, Fleet personnel fire live and inert ordnance at a vessel that is towed to a location in the western Atlantic Ocean. The specific objectives of an individual SINKEX vary, but may include training of personnel, weapons use training, study of ship structure durability, and certification of battle groups preparing for deployment.

1.7.9 Surveillance Towed Array Sensor System Low-Frequency Active Sonar System

In January 2001, the Navy completed a Final EIS/OEIS for the employment of the Surveillance Towed Array Sensor System (SURTASS) Low-Frequency Active (LFA) sonar system on a maximum of four ships in the Pacific-Indian ocean area and in the Atlantic-Mediterranean area. In 2003, the Navy prepared a Supplemental EIS (SEIS) to provide additional analyses pertaining to the Proposed Action; analyze potential effects for SURTASS LFA sonar system upgrades and include additional information on mitigation measures related to those effects; and provide additional information with respect to legislative changes to the MMPA. The Final SEIS was completed in April 2007 (DON, 2007). The Navy issued its ROD in August 2007, which applied geographic restrictions, including nine offshore biologically important areas, and monitoring before and during the use of SURTASS LFA sonar systems. The geographic restrictions ensure the sound field would be below 180 dB within 22 km (12 NM) of the coastline and within any offshore biologically important areas that exist beyond the 22 km (12 NM) zone. Monitoring would include visual monitoring from the SURTASS LFA sonar vessel for marine mammals and sea turtles, the use of passive SURTASS array to detect the sounds made by marine mammals as an indicator of their presence, and the use of high-frequency sonar to detect, locate, and track potentially affected marine mammals and sea turtles (DON, 2007).

In accordance with Section 7 of the ESA and MMPA, the Navy submitted a BA and a request for LOA to NMFS. In August 2007, NMFS issued a Final Rule for the incidental taking of marine mammals during SURTASS LFA sonar activities, effective August 16, 2007 through August 15, 2012 (NMFS, 2007i). The Final Rule determined that the operation of the SURTASS LFA sonar system for testing, training and military operations "will have a negligible impact on the affected species or stocks of marine mammals and will not have an unmitigable adverse impact on their availability for taking for subsistence uses" (NMFS, 2007i). Furthermore, NMFS concluded, "operation of the SURTASS LFA sonar system for testing, training, and military operations and the issuance by NMFS of MMPA incidental take authorizations for this activity are not likely to jeopardize the continued existence of any endangered or threatened species under the jurisdiction of NMFS or result in the destruction or adverse modification of critical habitat" (NMFS, 2007i). Cumulative impacts from the potential deployment of the SURTASS LFA sonar system in the Atlantic Ocean area are addressed in this EIS/OEIS (refer to Chapter 6).

1.8 CHANGES TO THE AFAST FINAL EIS/OEIS

The Navy has made changes to this AFAST Final EIS/OEIS based on comments received during the public comment period. These changes included factual corrections, additions to existing information, and improvements or modifications to the analyses presented in the AFAST Draft EIS/OEIS. A summary of public comments received and the Navy's response to these comments is provided in Appendix J. (All comment letters are available on the project website, http://afasteis.gcsaic.com.) None of the changes between the Draft and Final EIS/OEIS resulted in substantive changes to the Proposed Action, alternatives, or the significance of the environmental consequences of the Proposed Action.

2. DESCRIPTION OF THE PROPOSED ACTION AND ALTERNATIVES

The Proposed Action is for the Department of the Navy (DON) to designate areas where mid- and high-frequency active sonar and improved extended echo ranging (IEER) system training, maintenance, and research, development, test, and evaluation (RDT&E) activities will occur within and adjacent to existing operating areas (OPAREAs) and to conduct these activities. The IEER system consists of an explosive source sonobuoy (AN/SSQ-110A) and an air deployable active receiver (ADAR) sonobuoy (AN/SSQ-101). These areas will be used to accommodate the current level of Anti-Submarine Warfare (ASW) and Mine Warfare (MIW) training along the East Coast of the United States (U.S.) and within the Gulf of Mexico. This training is required to meet the needs delineated in the Surface, Air, and Submarine Force Training Manuals; Commander, Second Fleet deployment certification requirements; and to maintain proficiency in the ASW and MIW skills needed to meet the surge requirements outlined in the Fleet Response Training Plan (FRTP). In addition, RDT&E provides the Navy the capability of developing new active sonar and IEER systems and ensuring their safe and effective implementation. For the purposes of this document, "active sonar activities" refers to training, maintenance, and RDT&E activities involving mid- and high-frequency active sonar and the explosive source sonobuoy (AN/SSQ-110A).

2.1 ASW TRAINING, MIW TRAINING, MAINTENANCE, AND RDT&E ACTIVITIES

ASW and MIW training provides the warfighter with the skills necessary to function as part of a coordinated fighting force in a hostile environment with the capacity to accomplish multiple missions. The U.S. Navy Atlantic Fleet meets these requirements by conducting training activities prior to deployment of forces. Overall, ASW and MIW training is conducted to meet deployment certification requirements as directed in the FRTP. The FRTP formalizes the traditional Navy building block approach to training in a way that brings the strike groups to the required level of combat readiness earlier in the training cycle, and sustains that readiness longer. Training proceeds on a continuum in the FRTP, advancing through four phases: Maintenance, Basic, Integrated, and Sustainment.

The Maintenance Phase is the preferred period during which major shipyard or depot level repair and most personnel turnover occurs. Ship and squadrons will focus on individual and team ASW and MIW training. During the Basic Phase, the Navy continues individual and team training, but the focus shifts to Unit Level Training (ULT). In this document, the Basic Phase training is described as Independent ULT, which involves one unit and Coordinated ULT, which involves more than one unit. It is during the Basic Phase that fundamental combat skills are learned and practiced with further refinement during Coordinated ULT events. The Navy meets the requirement of the Integrated Phase through Strike Group Training when individual units come together as a strike group to synthesize staff actions and coordinate their operations in a challenging, multi-warfare environment using progressively more difficult, complex, and large-scale exercises conducted at an increasing tempo. This phase includes strike group-level assessment and certification prior to deployment. The Sustainment Phase begins upon completion of the Integrated Phase, lasts through deployment and for several months following return to homeport before the strike group stands down and the individual units begin their maintenance period. The Sustainment Phase can include a variety of ASW and MIW training evolutions designed to sustain warfighting readiness of a group, multi-unit, or unit attained in the prior three phases.

RDT&E activities are conducted as part of developing new technologies and to ensure their effectiveness prior to implementation. Maintenance activities are conducted pier side and during transit to training exercise locations. Active sonar maintenance is required to ensure the sonar system is operating properly prior to engaging in the training exercise or when the sonar systems are suspected of performing below optimal levels.

It should be noted that active sonar is rarely used continuously throughout the listed activities. In addition, when sonar is in use, the sonar "pings" occur at intervals, referred to as a duty cycle, and the signals themselves are very short in duration. The typical sonar use scenarios are described in more detail in Chapter 4.

For purposes of this EIS/OEIS, and ease of reference, this document has distinguished training events conducted by a single unit (Independent ULT) from those conducted by multiple units (Coordinated ULT).

2.2 SONAR SYSTEMS

There are two basic types of sonar, passive and active.

- ***Passive sonars*** are only used to listen to incoming sounds. Passive sonars do not emit sound energy into the water and cannot acoustically affect the environment. Therefore, although passive sonars are used, they are not acoustically analyzed in this Atlantic Fleet Active Sonar Training (AFAST) Environmental Impact Statement/Overseas Environmental Impact Statement (EIS/OEIS).
- ***Active sonars*** emit acoustic energy to obtain information concerning a distant object from the reflected sound energy. Active sonars are the most effective detection systems against modern ultra-quiet submarines and sea mines.

Refer to Figure 2-1 for a depiction of active and passive sonar capability.

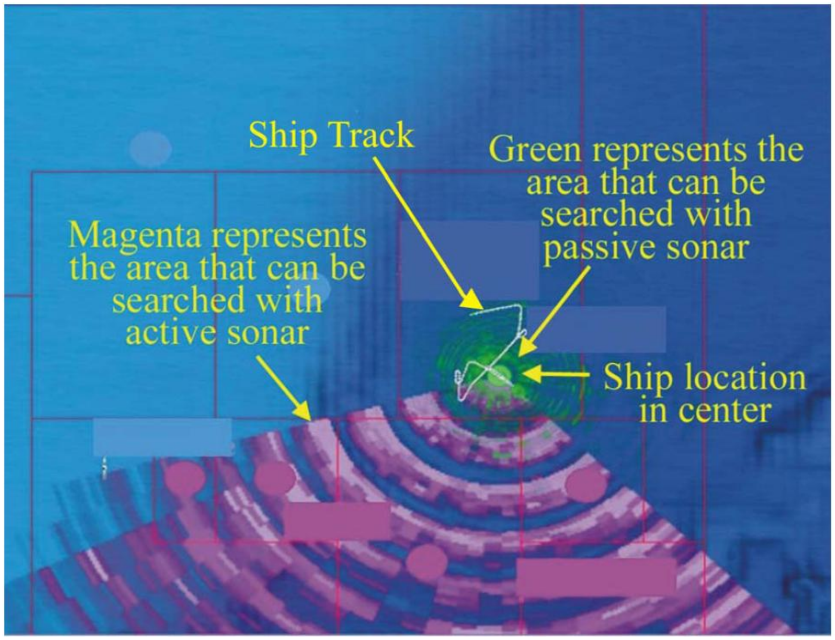


Figure 2-1. Comparative Detection Capability of Active and Passive Sonar

2.2.1 Sonars Modeled for Acoustic Effects Analysis

Modern sonar technology includes a multitude of sonar sensor and processing systems. In concept, the simplest active sonar emits sound waves, or "pings," sent out in multiple directions (i.e., is omnidirectional). Sound waves reflect off the target object and move in multiple directions. The time it takes for some of these sound waves to return to the sonar source is calculated to provide a variety of information, including the distance to the target object. More sophisticated active sonars emit an omnidirectional ping and then rapidly scan a steered receiving beam to provide directional as well as range information. Even more advanced sonars use multiple pre-formed beams to listen to echoes from several directions simultaneously and provide efficient detection of both direction and range. Table 2-1 identifies all of the acoustic systems used during Atlantic Fleet active sonar activities. The frequencies provided in the table are general operating frequencies for the systems modeled for the acoustic effects analysis.

Table 2-1 also identifies the systems that were not modeled as these systems are typically operated at frequencies greater than 200 kilohertz (kHz). It is important to note that, as a group, marine mammals have functional hearing ranging from 10 hertz (Hz) to 200 kHz; however, their best hearing sensitivities are well below 200 kHz. Since active sonar sources operating at 200 kHz or higher attenuate rapidly and are at or outside the upper frequency limit of even the ultrasonic species of marine mammals, modeling of these higher frequency acoustic sources was not warranted.

Table 2-1. Acoustic Systems Analyzed and Not Analyzed

Systems That Were Analyzed				
System	**Frequency**	**Source Level (re 1μPa)**	**Associated Platform**	**System Description**
AN/SQS-53	3.5 kHz	235 dB	DDG and CG hull-mounted sonar	ASW search, detection, and localization; utilized 70% in search mode and 30% track mode
AN/AQS-13[1]	10.0 kHz	215 dB	Helicopter dipping sonar	ASW sonar lowered from hovering helicopter (approximately 10 pings/dip, 30 seconds between pings)
AN/AQS-22	4.1 kHz	217 dB	Helicopter dipping sonar	ASW sonar lowered from hovering helicopter (approximately 10 pings/dip, 30 seconds between pings)
Explosive source sonobuoy (AN/SSQ-110A)	Impulsive broadband	Classified	MPA deployed	ASW system consists of explosive acoustic source buoy (contains two 4.1 lb charges) and expendable passive receiver sonobuoy
AN/SSQ-125	MF	Classified	MPA deployed	ASW system consists of active sonobuoy and expendable passive receiver sonobuoy
AN/SQQ-32	HF	Classified	MCM over the side system	Detect, classify, and localize bottom and moored mines
AN/BQS-15	HF	Classified	Submarine navigational sonar	Only used when entering and leaving port
AN/SQS-56	7.5 kHz	225 dB	FFG hull-mounted sonar	ASW search, detection, localization; utilized 70% in search mode and 30% track mode
MK-48 Torpedo	HF	Classified	Submarine fired exercise torpedo	Recoverable and non-explosive exercise torpedo; sonar is active approximately 15 min per torpedo run
MK-46/MK-54 Torpedo	HF	Classified	Surface ship and aircraft fired exercise torpedo	Recoverable and non-explosive exercise torpedo; sonar is active approximately 15 min per torpedo run
AN/SLQ-25 (NIXIE)	MF	Classified	DDG, CG, and FFG towed array	Towed countermeasure to avert localization and torpedo attacks (approximately 20 mins per use)
AN/SQS-53 and AN/SQS-56 (Kingfisher)	MF	Classified	DDG, CG, and FFG hull-mounted sonar (object detection)	Only used when entering and leaving port
AN/BQQ-10 and AN/BQQ-5	MF	Classified	Submarine hull-mounted sonar	ASW search and attack (approximately 1 ping every 2 hours when in use)
Tonal sonobuoy (DICASS) (AN/SSQ-62)	8 kHz	201 dB	Helicopter and MPA deployed	Remotely commanded expendable sonar-equipped buoy (approximately 12 pings, 30 secs between pings)

Table 2-1. Acoustic Systems Analyzed and Not Analyzed Cont'd

Systems That Were Analyzed Cont'd				
System	**Frequency**	**Source Level (re 1μPa)**	**Associated Platform**	**System Description**
ADC MK-1, MK-2, MK-3 and MK-4	MF	Classified	Submarine deployed countermeasure	Expendable acoustic countermeasure (approximately 20 mins per use)
Submarine deployed countermeasure (NAE)	MF	Classified	Submarine deployed countermeasure	Expendable acoustic countermeasure (approximately 20 mins per use)

Systems That Were Not Analyzed			
System	Frequency	Reason not Analyzed	System Description
Surface Ship Fathometer	12 kHz	System is not unique to military and operates identically to any commercially available bottom sounder.	Depth finder on surface ships
Submarine Fathometer	12 kHz	System is not unique to military and operates identically to any commercially available bottom sounder.	Depth finder on submarine
SQR-19	Passive	System is a passive towed array emitting no active sonar.	A listening device towed behind a surface ship
TB-16/23/29/33	Passive	System is a passive towed array emitting no active sonar.	A listening device towed behind a submarine
Passive Sonobuoy (DIFAR) (AN/SSQ-53)	Passive	Sonobuoys are passive and emit no active sonar	Passive listening buoys deployed from helicopter or MPA
AN/AQS-14	>200 kHz	System frequency outside the upper frequency limit for marine mammals	Helicopter towed array used in MIW for the detection of mines
AN/AQS-24	>200 kHz	System frequency outside the upper frequency limit for marine mammals	Helicopter towed array used in MIW for the detection of mines
AN/AQS-20	>200 kHz	System frequency outside the upper frequency limit for marine mammals	Helicopter towed array used in MIW for the detection of mines
AN/SLQ-48	>200 kHz	System frequency outside the upper frequency limit for marine mammals	A system that uses a remote-controlled submersible vehicle to identify underwater objects.

[1] AN/AQS-22 was used to model the AN/AQS-13.

ADC – Acoustic Device Countermeasure; CG – Guided Missile Cruiser; DDG – Guided Missile Destroyer; DICASS – Directional Command-Activated Sonobuoy System; DIFAR – Directional Frequency Analysis and Recording; FFG – Fast Frigate; HF – High-Frequency; IEER – Improved Extended Echo Ranging; kHz – Kilohertz; MCM – Mine Countermeasures; MF – Mid-Frequency; MIW – Mine Warfare; MPA – Maritime Patrol Aircraft; NAE – Noise Acoustic Emitter

Systems that were found to have similar acoustic output parameters (i.e., frequency, power, deflection angles) were compared. The system with the largest acoustic footprint was modeled as representative of those similar systems that have a smaller footprint. Specifically, the AN/AQS-22 was used to model the AN/AQS-13, the AN/BQQ-10 was used to model the AN/BQQ-5, and the MK-3 was used to model all countermeasures.

In addition, based on individual sonar parameters shown in Table 2-1 and the acoustic modeling, the AN/SQS-53 hull-mounted sonar was noted as being the most powerful of all the sonar systems analyzed. As a result, this sonar system has the largest acoustic footprint and was used during the surrogate analysis, which is discussed further in Section 2.6.2.

2.2.2 ASW Sonar Systems

ASW sonar systems are deployed from certain classes of surface ships, submarines, helicopters, and fixed-wing maritime patrol aircraft (MPA) (Table 2-2). The surface ships used are typically equipped with hull-mounted sonars (passive and active) for the detection of submarines. Helicopters equipped with dipping sonar or sonobuoys are utilized to locate suspect submarines or submarine targets within the training area. In addition, fixed-wing MPA are used to deploy both active and passive sonobuoys to assist in locating and tracking submarines during the duration of the exercise. Submarines involved in the exercises are equipped with hull-mounted sonars sometimes used to locate and prosecute other submarines and/or surface ships during the exercise. Mid-frequency (i.e., 1 to 10 kHz) active sonar is predominately used in ASW activities. The types of tactical acoustic sources employed during ASW sonar training exercises are included in this section. Refer to Appendix C, Exercise and Sonar Type Descriptions, for additional information.

The types of tactical acoustic sources that are used during Atlantic Fleet ASW active sonar activities include the following:

- **Surface Ship Sonars.** A variety of surface ships operate the AN/SQS-53 and AN/SQS-56 hull-mounted mid-frequency active sonar (Figure 2-2) during ASW sonar training exercises, including 10 cruisers (CGs), 26 guided missile destroyers (DDGs) (AN/SQS-53), and 18 fast frigates (FFGs) (AN/SQS-56) as of 2008. About half of the U.S. Navy ships do not have any onboard tactical sonar systems.

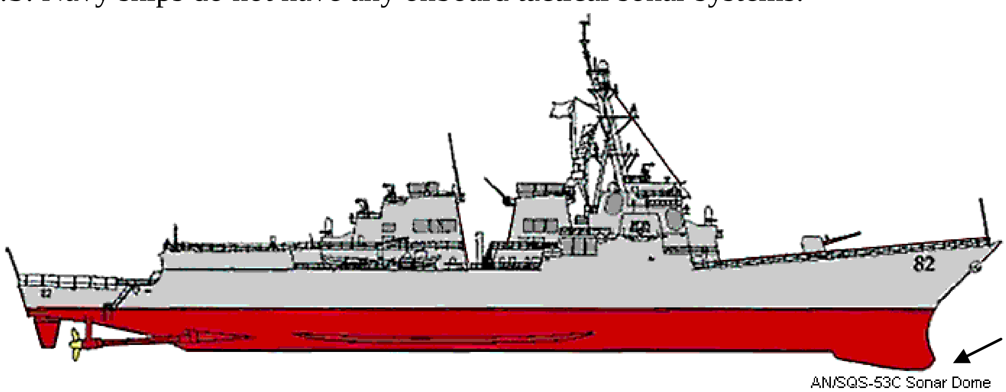


Figure 2-2. Guided Missile Destroyer with a AN/SQS-53 Sonar

- **Submarine Sonars.** Tactical military submarines (i.e. 29 attack submarines [SSNs] as of 2008) equipped with hull-mounted mid-frequency active sonars (Figure 2-3) are used to detect and target enemy submarines and surface ships. A submarine’s mission revolves around its stealth; therefore, mid-frequency active sonars are used very infrequently since the pinging of the mid-frequency active sonar also gives away the location of the submarine. Note that the AN/BQQ-10 is the more predominant system, and that the system is identified throughout the remainder of this document with the understanding that the AN/BQQ-5, AN/BSY-1/2, and AN/BQQ-10 are similar in those operational parameters with potential to affect marine mammals. In addition, Seawolf Class attack submarines, Virginia Class attack submarines, Los Angeles Class attack submarines, and Ohio Class nuclear guided missile submarines also have the AN/BQS-15, a sonar that uses high-frequency for under-ice navigation and mine-hunting.

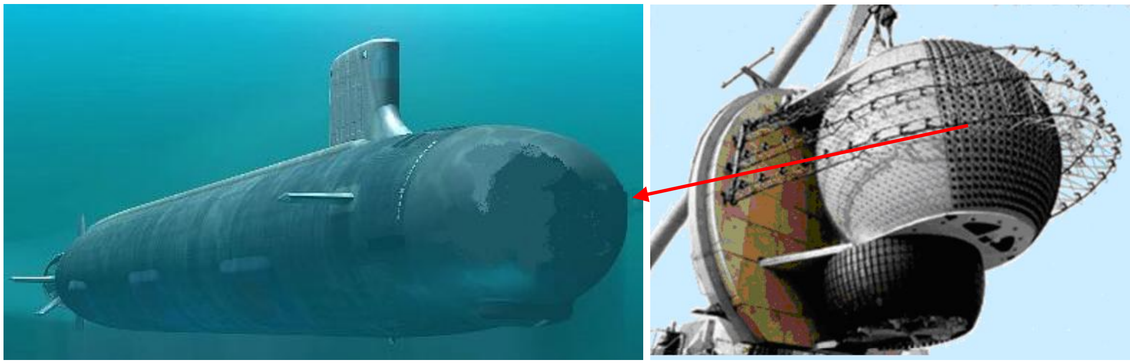


Figure 2-3. Submarine AN/BQQ-10 Active Sonar Array

- **Aircraft Sonar Systems.** Aircraft sonar systems that operate during ASW sonar activities include sonobuoys and dipping sonars.
    - **Sonobuoys.** Sonobuoys (Figure 2-4), deployed by both helicopter and fixed-wing MPA, are expendable devices that are either tonal (active), impulsive (explosive), or listening (passive). The Navy uses a tonal sonobuoy called a Directional Command-Activated sonobuoy System (DICASS) and a sonobuoy system called an IEER system, which consists of an explosive source sonobuoy (AN/SSQ-110A) and an ADAR sonobuoy (AN/SSQ-101). The Navy is developing the Advanced Extended Echo Ranging (AEER) system as a replacement to the IEER system. The AEER would use a new active sonobuoy (AN/SSQ-125) that utilizes a tonal (a ping) versus an impulsive (or explosive) sound source as a replacement for the AN/SSQ-110A. For the purposes of further discussion in this EIS/OEIS, where IEER is discussed, it can be implied to also account for AEER as AEER will be the replacement system. Therefore, as the AEER system is introduced for U.S. Fleet Forces (USFF) use, the IEER system will be removed. The AEER system will still use the ADAR sonobuoy as the systems receiver. The Navy also uses a passive sonobuoy called a Directional Frequency Analysis and Recording (DIFAR). Passive listening buoys such as DIFAR (AN/SSQ-53) are deployed from helicopters or maritime patrol aircraft and do not emit active sonar. These systems are used for the detection and tracking of submarine threats. The Navy is currently investigating use of tactical page buoys for communication with submerged submarines that are similar to DICASS sonobuoys in frequency and source level.

DICASS Sonobuoy

Loading sonobuoys on to aircraft

Figure 2-4. DICASS Sonobuoys (e.g., AN/SSQ-62)

- **Dipping Sonars.** Dipping active/passive sonars (Figure 2-5), present on helicopters, are recoverable devices that are lowered via a cable to detect or maintain contact with underwater targets. The Navy uses the AN/AQS-13 and AN/AQS-22 dipping sonars. Helicopters can be based ashore or aboard a ship.

Figure 2-5. AN/AQS-22 Dipping Sonar

- **Torpedoes**. Torpedoes are the primary ASW weapons used by surface ships, aircraft, and submarines (Figure 2-6). The guidance systems of these weapons can be autonomous or electronically controlled from the launching platform through an attached wire. The autonomous guidance systems are acoustically based. They operate either passively, by listening for sound generated by the target, or actively, by pinging the target and using the echoes for guidance. All torpedoes to be used during ASW activities are recoverable and nonexplosive. The majority of torpedo firings occurring during AFAST active sonar activities are air slugs, water slugs (dry fire) or shapes (i.e., solid masses resembling the weight and shape of a torpedo).

Figure 2-6. Depiction of MK-48 Torpedo Loaded onto Submarine

- **Acoustic Device Countermeasures.** Several types of countermeasure devices could be deployed during Fleet training exercises, including the Acoustic Device Countermeasure MK-1, MK-2, MK- 3, MK-4, the Noise Acoustic Emitter (NAE), and the AN/SLQ-25A (NIXIE). Countermeasure devices act as decoys to avert localization and torpedo attacks. Countermeasures are towed or free floating sources of mid-frequency sound energy.

- **Training Targets.** ASW training targets are used to simulate target submarines. They are equipped with one or more of the following devices: (1) acoustic projectors emanating sounds to simulate submarine acoustic signatures, (2) echo repeaters to simulate the characteristics of the echo of a particular sonar signal reflected from a specific type of submarine, and (3) magnetic sources to trigger magnetic detectors. The Navy uses the Expendable Mobile Acoustic Training Target (EMATT) and the MK-30 acoustic training targets (recoverable) during ASW sonar training exercises (Figure 2-7).

MK 30 Recoverable Sub Simulator Target

Figure 2-7. U.S. Navy MK-30 Sub Simulator Target

Logistic support ships and aircraft are sometimes used in active sonar training activities to deliver and recover targets. However, the logistical support platforms that are used for recovery either are not equipped with sonar capabilities or do not utilize their sonar system during the recovery effort.

2.2.3 MIW Sonar Systems

There are a variety of different sonar systems that could be used during MIW sonar training exercises. These are typically high-frequency sonars (i.e., greater than 10 kHz) used to detect, locate, and characterize moored and bottom mines. In addition, the majority of the MIW sonar sensors used can be deployed by more than one platform (i.e., helicopter-towed body, unmanned underwater vehicle [UUV], surf zone crawler, or surface ship) and may be interchangeable. The majority of MIW systems are deployed by helicopters and typically operate at high (greater than 200 kHz) frequencies. (Refer to Appendix C, Exercise and Sonar Type Descriptions, for additional information.) The types of tactical acoustic sources used during MIW sonar training activities include the following:

- **Surface Ship Sonars.** DDGs, FFGs, and CGs can utilize their hull-mounted sonars (AN/SQS-53 and AN/SQS-56) in the object detection (Kingfisher) mode. These ships, as well as mine hunters, may utilize over-the-side UUV systems containing sonar sensor packages to detect and classify mine shapes. Navy minesweepers use the AN/SQQ-32, a variable depth mine detection and classification high-frequency active sonar system. In addition, mine hunters are equipped with underwater acoustic communication systems.
- **Submarine Sonars.** Submarines use a sail-mounted sonar, the AN/BQS-15, to detect mines and objects.

2.3 REPRESENTATIVE ACTIVE SONAR USE AND ACOUSTIC SOURCES

For purposes of the analysis in this EIS/OEIS, active sonar use was distributed throughout the AFAST Study Area based on actual usage reported by the sonar positional reporting system. Because the Navy conducts many different types of Independent ULT, Coordinated ULT, Strike Group training, maintenance, and RDT&E active sonar events (set forth in Appendix C), the Navy grouped similar events to form representative scenarios. These representative scenarios describe the scope of activities that are analyzed in this EIS/OEIS. Note that specific exercise names and other details occasionally change as required to meet the current operational needs. The distribution of operations throughout the OPAREAs may vary based on emergent needs; however, the distribution of events shown is typical based on past events. Table 2-2 summarizes the scenarios described in subsequent sections, and Table 2-3 summarizes the annual events by OPAREA.

Table 2-2. Summary of Active Sonar Activities

Event Type	Event Name	Training Event Scenarios	Events per Year*	Length of Overall Event	Possible Event Areas**	Typical Event Area Dimensions	Equipment or Action	Equipment Use or Action per Event	Annual Use per Event Type*	Effects Considered
Independent Unit Level Training (including RDT&E)	Surface Ship ASW ULT	One or two surface ships (CG, DDG, and FFG) conducting ASW localization and tracking training.	457	2 to 6 hours	VACAPES, CHPT, JAX/CHASN, and GOMEX OPAREAs	5 NM x 10 NM to 30 NM x 40 NM	Surface ship MFA ASW sonar (AN/SQS-53 or AN/SQS-56)	1 to 2 ships (CG, DDG, or FFG) pinging 1 to 3 hours each	1071 hours AN/SQS-53 and 465 hours AN/SQS-56	MFA sonar exposure
							Acoustic countermeasures (AN/SLQ-25 NIXIE, MK-1, MK-2, MK-3, MK-4, or Noise Acoustic Emitter)	2 hours per NIXIE 20 minutes per MK-1, MK-2, MK-3, or MK-4 Noise Acoustic Emitter	158 NIXIE 225 MK-1, MK-2, MK-3, or MK-4 127 Noise Acoustic Emitter	MFA sonar exposure and expended materials
							MK-46 or MK-54 Torpedo	Exercise torpedoes could be used for RDT&E	8 MK-46 or MK-54 exercise torpedoes	HFA sonar exposure, direct strike, and expended materials
							MK-39 EMATT or MK-30 target	1 EMATT or MK-30 (recoverable) per exercise may be used as a target	up to 725 EMATTs expended (total annual use for all exercises)	Direct strike and expended materials
							Vessel movement	1 to 2 ships maneuvering	Approximately 54 CG, DDG, and FFG surface ships conducting ULT throughout the year	Vessel strike
	Surface Ship Object Detection ULT	One ship (CG, DDG, and FFG) conducting object detection during transit in/out of port for training and safety during reduced visibility.	108	1 to 2 hours	Sea lanes and Entrance channels to Norfolk, Virginia and Mayport, Florida	5 NM x 10 NM	Surface ship MFA ASW sonar (AN/SQS-53 or AN/SQS-56 Kingfisher) operated in object detection mode	1 ship (CG, DDG, or FFG) pinging for 1 to 2 hours	148 hours AN/SQS-53 and 68 hours AN/SQS-56	MFA sonar exposure
							Vessel movement	1 ship maneuvering	Approximately 54 CG, DDG, and FFG surface ships on the East Coast conducting object avoidance twice a year	Vessel strike
	Helicopter ASW ULT	One helicopter conducting ASW training using dipping sonar or sonobuoys	165	2 to 4 hours	VACAPES, CHPT, and JAX/CHASN OPAREAs	20 NM x 30 NM	Helicopter dipping sonar (AN/AQS-13 or AN/AQS-22)	1 helicopter dipping up to two hours (10 pings per five-minute dip)	160 hours	MFA sonar exposure
							Tonal sonobuoy (DICASS) (AN/SSQ-62)	Up to 4 tonal sonobuoys (DICASS)	549 sonobuoys	MFA sonar exposure, direct strike, and expended materials
							Passive sonobuoy (DIFAR) AN/SSQ-53D/E	Number of sonobuoys deployed can vary	up to 27,500 sonobuoys expended (total annual use for all exercises)	Expended materials and direct strike
							MK-46 or MK-54 Torpedo	exercise torpedoes could be used for RDT&E	8 MK-46 or MK-54 exercise torpedoes	HFA sonar exposure, direct strike, and expended materials
							MK-39 EMATT or MK-30 target	1 EMATT or MK-30 (recoverable) per exercise may be used as a target	up to 725 EMATTs expended (total annual use for all exercises)	Direct strike and expended materials
	Submarine ASW ULT	One submarine conducting ASW and SUW training using passive and active sonar.	100	2 to 3 days	Northeast, VACAPES, CHPT, JAX/CHASN, and GOMEX OPAREAs	30 NM x 40 NM	Submarine MFA sonar (AN/BQQ-10)	1 submarine pinging once per two hours (average 36 pings per event)	3600 pings	MFA sonar exposure
							MK-48 Torpedo	Number of exercise torpedoes could be used in a single RDT&E event could vary	32 MK-48 exercise torpedoes	HFA sonar exposure, direct strike, and expended materials
							Vessel movement	1 submarine maneuvering	Approximately 25 submarines on the East Coast conducting ULT throughout the year	Vessel strike
							MK-39 EMATT or MK-30 target	1 EMATT or MK-30 (recoverable) per exercise may be used as a target	up to 725 EMATTs expended (total annual use for all exercises)	Direct strike and expended materials
							Tactical page buoy	1 tactical page buoy may be deployed	up to 60 buoys expended	Expended materials

Table 2-2. Summary of Active Sonar Activities Cont'd

Event Type	Event Name	Training Event Scenarios	Events per Year*	Length of Overall Event	Possible Event Areas**	Typical Event Area Dimensions	Equipment or Action	Equipment Use or Action per Event	Annual Use per Event Type*	Effects Considered
Independent Unit Level Training (including RDT&E) Cont'd	Submarine Navigational	One submarine operating sonar for navigation and object detection during transit in/out of port during reduced visibility.	300	1 to 2 hours	Sea lanes and entrance channels to Norfolk, Virginia; Groton, Connecticut; and Kings Bay, Georgia	5 NM x 10 NM	Submarine MFA and HFA object detection sonar (AN/BQQ-10 or AN/BQS-15)	1 submarine pinging 1 to 2 hours	450 hours	MFA and HFA sonar exposure
							Vessel movement	1 submarine maneuvering	Approximately 30 submarines on the East Coast conducting ULT throughout the year	Vessel strike
	MPA ASW ULT (tonal sonobuoy)	One MPA conducting ASW submarine localization and tracking training using tonal sonobuoys.	791	2 to 8 hours	Northeast, VACAPES, CHPT, JAX/CHASN, and GOMEX OPAREAs	30 NM x 30 NM to 60 NM x 60 NM	Tonal sonobuoy (DICASS) (AN/SSQ-62)	Up to 10 tonal sonobuoys (DICASS)	3594 sonobuoys	MFA sonar exposure, direct strike, and expended materials
							Passive sonobuoy (DIFAR) AN/SSQ-53D/E	Number of sonobuoys deployed can vary	up to 27,500 sonobuoys expended (total annual use for all exercises)	Expended materials and direct strike
							MK-46 or MK-54 Torpedo	exercise torpedoes could be used for RDT&E	8 MK-46 or 54 exercise torpedoes	HFA sonar exposure, direct strike, and expended materials
							MK-39 EMATT (repeater) and or MK-30 Target	1 EMATT or MK-30 (recoverable) per exercise may be used as a target	up to 725 EMATTs expended (total annual use for all exercises)	direct strike and expended materials
	MPA ASW ULT (explosive source sonobuoy [AN/SSQ-110A])	One MPA conducting ASW submarine localization and tracking training using explosive source sonobuoy (AN/SSQ-110A).	169	2 to 8 hours	Northeast, VACAPES, CHPT, JAX/CHASN, and GOMEX OPAREAs	60 NM x 60 NM	Explosive source sonobuoy (AN/SSQ-110A)	Up to 14 AN/SQ-110A sonobuoys	676 sonobuoys	Explosive byproducts, pressure wave exposure, impulsive sound exposure, direct strike, and expended materials
							Receiver (ADAR) sonobuoy (AN/SSQ-101)	Up to 5 AN/SSQ-101 sonobuoys	239 sonobuoys	Direct Strike and expended materials
	Surface Ship MIW ULT	One ship (MCM) conducting mine localization training.	266	Less than 24 hours	GOMEX OPAREA	1 NM x 2 NM	Surface ship HFA MIW sonar (AN/SQQ-32)	1 ship (MCM) pinging for 1 to 15 hours	2074 hours of AN/SQQ-32	HFA sonar exposure
							Vessel movement	1 to 2 ships maneuvering	Approximately 19 MIW surface ships conducting ULT throughout the year	Vessel strike
Coordinated Unit Level Training	Southeastern Anti-Submarine Warfare Integrated Training Initiative (SEASWITI) and similar RDT&E	An exercise with two DDGs, one FFG with embarked helicopter, two submarines, and one MPA	4 training events and similar RDT&E	5 to 7 days	JAX/CHASN OPAREA	30 NM x 30 NM	Surface ship MFA ASW sonar (AN/SQS-53 or AN/SQS-56)	2 to 3 ships (CG, DDG, or FFG) pinging daily for several hours	440 hours AN/SQS-53 200 hours AN/SQS-56	MFA sonar exposure
							Helicopter ASW dipping sonar (AN/AQS-13 or AN/AQS-22)	1 helicopter dipping several times daily (10 pings per five-minute dip)	10 hours	MFA sonar exposure
							Submarine MFA sonar (AN/BQQ-5 or AN/BQQ-10)	1 submarine pinging up to four times daily	100 pings	MFA sonar exposure
							Acoustic countermeasures (AN/SLQ-25 NIXIE, MK-2, MK-3, or Noise Acoustic Emitter)	2 hours per NIXIE 20 minutes per MK-2, MK-3, and Noise Acoustic Emitter	ADCs may be used during the event; annual total ADC expenditure shown under ASW Surface ULT	MFA sonar exposure, direct strike, and expended materials
							Tonal sonobuoy (DICASS) (AN/SSQ-62)	1 MPA dropping up to 8 sonobuoys in one day; 24 sonobuoys for entire SEASWITI	120 tonal sonobuoys (DICASS)	MFA sonar exposure, direct strike, and expended materials
							Passive sonobuoy (DIFAR) AN/SSQ-53D/E	Number of sonobuoys deployed can vary	up to 27,500 sonobuoys expended (total annual use for all exercises)	Expended materials and direct strike
							Vessel movement	3 to 4 ships maneuvering	3 to 4 ships maneuvering over 5-7 days, up to four times a year	Vessel strike

Table 2-2. Summary of Active Sonar Activities Cont'd

Event Type	Event Name	Training Event Scenarios	Events per Year*	Length of Overall Event	Possible Event Areas**	Typical Event Area Dimensions	Equipment or Action	Equipment Use or Action per Event	Annual Use per Event Type*	Effects Considered
Coordinated Unit Level Training Cont'd	Integrated ASW Course (IAC)	An exercise with three DDGs, one CG, one FFG, two to three helicopters, one to two submarines, and one MPA	5	2 to 5 days	VACAPES, CHPT, and JAX/CHASN OPAREAs	120NM X 60NM	Surface ship MFA ASW sonar (AN/SQS-53 or AN/SQS-56)	5 ships pinging for up to 10 hours	285 hours AN/SQS-53 100 hours AN/SQS-56	MFA sonar exposure
							Helicopter ASW dipping sonar (AN/AQS-13 or AN/AQS-22)	1 helicopter dipping up to one hour (10 pings per five-minute dip)	5 hours AN/AQS-13 or AN/AQS-22	MFA sonar exposure
							Submarine MFA sonar (AN/BQQ-5 or AN/BQQ-10)	1-2 submarines pinging up to 6 times each	60 pings	MFA sonar exposure
							Acoustic countermeasures (AN/SLQ-25 NIXIE, MK-2, MK-3, or Noise Acoustic Emitter)	2 hours per NIXIE 20 minutes per MK-2, MK-3, and Noise Acoustic Emitter	ADCs may be used during the event; annual total ADCs used shown under ASW Surface ULT	MFA sonar exposure, direct strike, and expended materials
							Tonal sonobuoy (DICASS) (AN/SSQ-62)	Helicopters and/or MPA dropping up to 36 sonobuoys	180 sonobuoys	MFA sonar exposure, direct strike, and expended materials
							Passive sonobuoy (DIFAR) AN/SSQ-53D/E	Number of sonobuoys deployed can vary	up to 27,500 sonobuoys expended (total annual use for all exercises)	Expended materials and direct strike
	Group Sail	An exercise with two DDGs with embarked helicopters, and one submarine.	20	2 to 3 days	VACAPES, CHPT, and JAX/CHASN OPAREAs	30 NM x 30 NM	Surface ship MFA ASW sonar (AN/SQS-53 or AN/SQS-56)	2-3 ships pinging for several hours	240 hours AN/SQS-53 120 hours AN/SQS-56	MFA sonar exposure
							Helicopter ASW dipping sonar (AN/AQS-13 or AN/AQS-22)	1 helicopter dipping up to 6 hours (10 pings per five-minute dip)	60 hours AN/AQS-13 or AN/AQS-22	MFA sonar exposure
							Submarine MFA sonar (AN/BQQ-5 or AN/BQQ-10)	1 submarine pinging up to two times	40 pings	MFA sonar exposure
							Acoustic countermeasures (AN/SLQ-25 NIXIE, MK-2, MK-3, or Noise Acoustic Emitter)	2 hours per NIXIE 20 minutes per MK-2, MK-3, and Noise Acoustic Emitter	ADCs may be used during the event; annual total ADCs used shown under ASW Surface ULT	MFA sonar exposure, direct strike, and expended materials
							Tonal sonobuoy (DICASS) (AN/SSQ-62)	1 helicopter dropping up to 4 sonobuoys	80 sonobuoys	MFA sonar exposure, direct strike, and expended materials
							Passive sonobuoy (DIFAR) AN/SSQ-53D/E	Number of sonobuoys deployed can vary	up to 27,500 sonobuoys expended (total annual use for all exercises)	Expended materials and direct strike
							Vessel movement	3 ships maneuvering	3 ships maneuvering over 5-7 days, up to 20 times a year	Vessel strike
	Submarine Command Course (SCC) Operations	Two submarines operating against each other as part of the SCC for prospective submarine Commanding Officers.	2	3 to 5 days	NE and JAX/CHASN OPAREAs	30 NM x 50 NM	Submarine MFA sonar (AN/BQQ-5 or AN/BQQ-10)	2 submarines pinging up to 12 times each	48 pings	MFA sonar exposure
							Acoustic countermeasures (MK-2, MK-3, or Noise Acoustic Emitter)	20 minutes per MK-2, MK-3, and Noise Acoustic Emitter	ADCs may be used during the event; annual total ADCs used shown under ASW Surface ULT	MFA sonar exposure, expended materials
							Vessel movement	2 submarines maneuvering	Maneuvering twice a year for 3-5 days	Vessel strike
	RONEX and GOMEX MIW Exercises	One to five MCM ships conducting mine localization training.	8	10 to 15 days	GOMEX OPAREA	20 NM x 20 NM	Surface ship HFA MIW sonar (AN/SQQ-32 and AN/SLQ-48)	1 to 5 ships (MCM) 60-90 hours each	2,400 hours AN/SQQ-32	HFA sonar exposure
							Vessel movement	1 to 5 ships (MCM) maneuvering	1 to 5 ships maneuvering up to 100 days a year	Vessel strike

Table 2-2. Summary of Active Sonar Activities Cont'd

Event Type	Event Name	Training Event Scenarios	Events per Year*	Length of Overall Event	Possible Event Areas**	Typical Event Area Dimensions	Equipment or Action	Equipment Use or Action per Event	Annual Use per Event Type*	Effects Considered
Strike Group Training	ESG COMPTUEX and CSG COMPTUEX and similar RDT&E	Intermediate level battle group exercise designed to create a cohesive CSG/ ESG prior to deployment or JTFEX. Three DDGs, one FFG, helicopters, one MPA, and two submarines.	5 training events and similar RDT&E	21 days	VACAPES, CHPT, JAX/CHASN, and GOMEX OPAREAs	60 NM x 120 NM	Surface ship MFA ASW sonar (AN/SQS-53 and AN/SQS-56)	4 ships (CG, DDG, or FFG) pinging approximately 60 hours each over 10 days	740 hours AN/SQS-53 250 hours AN/SQS-56	MFA sonar exposure
							Helicopter ASW dipping sonar (AN/AQS-13 or AN/AQS-22)	1 to 4 helicopters (10 pings per five-minute dip) during CSG COMPTUEX	9 hours	MFA sonar exposure
							Submarine MFA sonar (AN/BQQ-5 or AN/BQQ-10)	2 submarines pinging up to 16 times each	116 pings	MFA sonar exposure
							Acoustic countermeasures (AN/SLQ-25 NIXIE, MK-2, MK-3, or Noise Acoustic Emitter)	2 hours per NIXIE 20 minutes per MK-2, MK-3, and Noise Acoustic Emitter	ADCs may be used during the event; annual total ADCs used shown under ASW Surface ULT	MFA sonar exposure, direct strike, and expended materials
							Tonal sonobuoy (DICASS) (AN/SSQ-62)	MPA and/or helicopter dropping 3 to 10 sonobuoys for a total of up to 218 sonobuoys over duration of event	982 sonobuoys	MFA sonar exposure, direct strike, and expended materials
							Passive sonobuoy (DIFAR) AN/SSQ-53D/E	Number of sonobuoys deployed can vary	up to 27,500 sonobuoys expended (total annual use for all exercises)	Expended materials and direct strike
							Explosive source sonobuoy (AN/SSQ-110A)	2 MPA dropping up to 14 AN/SQ-110A sonobuoys	140 sonobuoys	Explosive byproducts, pressure wave exposure, impulsive sound exposure, direct strike, and expended materials
							Receiver (ADAR) sonobuoy (AN/SSQ-101)	Up to 5 AN/SSQ-101 sonobuoys	49 sonobuoys	Direct Strike and expended materials
							Vessel movement	6 ships (CG, DDG, FFG, or submarine) maneuvering	6 ships maneuvering up to 147 days a year	Vessel strike
	JTFEX	Final fleet exercise prior to deployment of the CSG and ESG. Serves as a ready-to-deploy certification for all units. Four DDGs, two FFGs, one helicopter, one MPA, and three submarines.	2	10 days	JAX/CHASN and GOMEX OPAREAs	60 NM x 80 NM up to 180 NM x 180 NM	Surface ship MFA ASW sonar (AN/SQS-53 or AN/SQS-56)	6 ships (CG, DDG, FFG) pinging up to 25 hours each	200 hours AN/SQS-53 100 hours AN/SQS-56	MFA sonar exposure
							Helicopter ASW dipping sonar (AN/AQS-13 or AN/AQS-22)	1 helicopters dipping for up to one hour (10 pings per five-minute dip)	2 hours	MFA sonar exposure
							Submarine MFA sonar (AN/BQQ-5 or AN/BQQ-10)	3 submarines pinging twice each	12 pings	MFA sonar exposure
							Acoustic countermeasures (AN/SLQ-25 NIXIE, MK-2, MK-3, or Noise Acoustic Emitter)	2 hours per NIXIE 20 minutes per MK-2, MK-3, and Noise Acoustic Emitter	ADCs may be used during the event; annual total ADCs used shown under ASW Surface ULT	MFA sonar exposure, direct strike, and expended materials
							Tonal sonobuoy (DICASS) (AN/SSQ-62)	1 MPA and/or 1 helicopter dropping 3 to 10 sonobuoys for a total of up to 174 sonobuoys over duration of event	348 sonobuoys	MFA sonar , direct strike, and expended materials
							Passive sonobuoy (DIFAR) AN/SSQ-53D/E	Number of sonobuoys deployed can vary	up to 27,500 sonobuoys expended (total annual use for all exercises)	Expended materials and direct strike
							Explosive source sonobuoy (AN/SSQ-110A)	2 MPA dropping up to 14 AN/SSQ-110A sonobuoys	56 sonobuoys	Explosive byproducts, pressure wave exposure, impulsive sound exposure, direct strike, and expended materials
							Receiver (ADAR) sonobuoy (AN/SSQ-101)	Up to 5 AN/SSQ-101 sonobuoys	20 sonobuoys	Direct Strike and expended materials
							Vessel movement	9 ships (CG, DDG, FFG, or submarine) maneuvering	Up to 9 ships maneuvering for up to 40 days a year	Vessel strike

Table 2-2. Summary of Active Sonar Activities Cont'd

Event Type	Event Name	Training Event Scenarios	Events per Year*	Length of Overall Event	Possible Event Areas**	Typical Event Area Dimensions	Equipment or Action	Equipment Use or Action per Event	Annual Use per Event Type*	Effects Considered
Maintenance	Surface Ship Sonar Maintenance	Pier side and at-sea maintenance to sonar system.	410	.2 to 4 hours	Northeast, VACAPES, CHPT, and JAX/CHASN, OPAREAs		Surface ship MFA ASW sonar (AN/SQS-53 OR AN/SQS-56)	1 ship (CG, DDG, or FFG) pinging	238 hours AN/SQS-53 449 hours AN/SQS-56	MFA sonar exposure
	Submarine Sonar Maintenance	Pier side and at-sea maintenance to sonar system.	200	1 hour	Northeast, VACAPES, CHPT, and JAX/CHASN, OPAREAs		Submarine MFA sonar (AN/BQQ-5 or AN/BQQ-10)	1 submarine pinging for up to one hour (60 pings per hour)	6000 pings (100 total hours of active sonar)	MFA sonar exposure

* Number of events and total hours modeled for acoustic effects analysis.
** OPAREAs also include area seaward of each OPAREA unless otherwise noted.

ADC – Acoustic Device Countermeasure; ASW – Antisubmarine Warfare; CHPT – Cherry Point; CG – Guided Missile Cruiser; COMPTUEX – Composite Training Unit Exercise; CSG – Carrier Strike Group; DDG – Guided Missile Destroyer; DICASS – Directional Command-Activated Sonobuoy System; EMATT – Expendable Mobile Acoustic Training Target; ESG – Expeditionary Strike Group; FFG – Fast Frigate; GOMEX – Gulf of Mexico; HFA – High-Frequency Active; IEER – Improved Extended Echo Ranging; kHz – Kilohertz; JAX/CHASN – Jacksonville/Charleston; JTFEX – Joint Task Force Exercise; MCM – Mine Countermeasures; MFA – Mid-Frequency Active; MIW – Mine Warfare; MPA – Maritime Patrol Aircraft; NM – Nautical Mile; OPAREA – Operating Area; RONEX – Squadron Exercise; SCC OPS – Submarine Command Course Operations; SEASWITI – Southeastern Anti-Submarine Warfare Integrated Training Initiative; SUW – Surface Warfare; TORPEX – Torpedo Exercise; ULT – Unit Level Training; VACAPES – Virginia Capes

This page is intentionally blank.

Table 2-3. Events per Year by Operating Area

Scenario	OPAREA					
	NE	VACAPES	CHPT	JAX/ CHASN	GOMEX	TOTAL
Independent ULT						
Surface Ship ASW		69	91	292	5	457
Surface Ship Object Detection/Navigational Sonar		68		40		108
Helicopter ASW		25	25	115		165
Submarine ASW	30	10	14	45	1	100
Submarine Object Detection/Navigational Sonar	165	78		57		300
MPA ASW (tonal sonobuoy)	238	79	111	356	7	791
MPA ASW (explosive source sonobuoy)	34	34	34	34	34	170
Surface Ship MIW					266	266
Coordinated ULT						
SEASWITI				4		4
IAC		0.2	1.4	2.4	1	5
Group Sail		3	4	13		20
SCC Operations	0.4			1.6		2
RONEX and GOMEX Exercises					8	8
Strike Group Training						
ESG COMPTUEX and CSG COMPTUEX*		0.2	1.4	2.4	1**	5
JTFEX		0.2	0.6	1.2	0	2
Maintenance						
Surface Ship Sonar Maintenance		61	82	263	4	410
Submarine Sonar Maintenance	30	10	14	45	1	100

* COMPTUEX distribution reflects the typical distribution of COMPTUEXs across OPAREA boundaries.
** All events are considered equally likely to occur at any time during the year, except strike group exercises, which would not occur in the GOMEX OPAREA during hurricane season (summer and fall).

ASW – Antisubmarine Warfare; CHPT – Cherry Point; COMPTUEX – Composite Training Unit Exercise; CSG – Carrier Strike Group; ESG – Expeditionary Strike Group; GOMEX – Gulf of Mexico; IAC – Integrated ASW Course; JAX/CHASN – Jacksonville/Charleston; JTFEX – Joint Task Force Exercise; MIW – Mine Warfare; MPA – Maritime Patrol Aircraft; NE – Northeast; OPAREA – Operating Area; RONEX – Squadron Exercise; SCC – Submarine Command Course; SEASWITI – Southeastern Antisubmarine Warfare Integrated Training Initiative; TORPEX – Torpedo Exercise; ULT – Unit Level Training; VACAPES – Virginia Capes

2.3.1 Independent Unit Level Training Scenarios

Independent ULT events typically last two to six hours and involve one or two ships or aircraft. Active sonar is typically not used during the entire event.

2.3.1.1 Surface Ship ASW ULT

One or two surface ships (CG, DDG, or FFG) conduct ASW localization and tracking training using the AN/SQS-53 and/or AN/SQS-56. The AN/SLQ-25 NIXIE may be employed. Additionally, one MK-39 EMATT or MK-30 target per scenario may be employed as a target. In some Surface Ship ASW ULT events a MK-1, MK-2, MK-3, MK-4, MK-46 torpedo, and a NAE could be used. Under the No Action Alternative, Surface Ship ASW ULT would be occurring in both deep and shallow water areas throughout the eastern and southeastern coast of the United States.

2.3.1.2 Surface Ship Object Detection/Navigational Training ULT

Under this scenario, one ship (CG, DDG, or FFG) conducts object detection and navigational training while transiting in and out of port using either the AN/SQS-53 or AN/SQS-56 in the Kingfisher mode. This training would be conducted primarily in the shallow water shipping lanes off the coasts of Norfolk, Virginia and Mayport, Florida.

2.3.1.3 Helicopter ASW ULT

In this scenario, one SH-60 helicopter conducts ASW training using the AN/AQS-13 or AN/AQS-22 dipping sonar, tonal sonobuoys (e.g., AN/SQQ-62), passive sonobuoy (AN/SSQ-53D/E), and torpedoes. One MK-39 EMATT or MK-30 target may also be employed as a target per scenario. This activity would be conducted in shallow and deep waters while embarked on a surface ship. Helicopter ASW ULT events would also be conducted by helicopters deployed from shore-based Jacksonville, Florida, units.

2.3.1.4 Submarine ASW ULT

This scenario consists of one submarine conducting underwater ASW training using the AN/BQQ-10 active sonar and torpedoes. Additionally, an MK-39 EMATT or MK-30 target may be used as a target. Submarines would be conducting this training in deep waters throughout the Study Area, within and seaward of existing East Coast OPAREAs and occasionally in the GOMEX OPAREA.

2.3.1.5 Submarine Object Detection/Navigational Training ULT

This scenario consists of one submarine conducting object detection and navigational training while transiting in and out of port using the AN/BQS-15 sonar. In this scenario, the submarine would be operating the sonar to detect obstructions during transit. This ULT would occur primarily in the established submarine transit lanes outside of Groton, Connecticut; Norfolk, Virginia; and Kings Bay, Georgia.

2.3.1.6 Maritime Patrol Aircraft ASW ULT

Under this scenario, one MPA conducts ASW localization and tracking training using tonal (AN/SSQ-62), passive (AN/SSQ-53D/E), explosive source (AN/SSQ-110A) or receiver (AN/SSQ-101) sonobuoys. Additionally, one MK-39 EMATT or MK-30 target for each training scenario may be used as a target. MPA ASW ULT would be occurring within and seaward of existing East Coast OPAREAs and occasionally within the Gulf of Mexico (GOMEX) OPAREA.

2.3.1.7 Surface Ship MIW ULT

During a surface ship MIW ULT, one ship (mine countermeasures [MCM]) would conduct mine localization training using the AN/SQQ-32 and the AN/SLQ-48 sonar systems. This training would be conducted in the northern Gulf of Mexico in the GOMEX OPAREA, and off the east coast of Texas, in the Corpus Christi OPAREA.

2.3.2 Coordinated Unit Level Training

2.3.2.1 Southeastern Anti-Submarine Warfare Integrated Training Initiative

The Southeastern Anti-Submarine Warfare Integrated Training Initiative (SEASWITI) is an exercise with up to two submarines and either two DDGs and one FFG or one CG, one DDG, and one FFG. The ships and their embarked helicopters would be conducting ASW localization training using the AN/SQS-53, AN/SQS-56, and AN/AQS-13 or AN/AQS-22 dipping sonar. The submarine also periodically operates the AN/BQQ-10 sonar. Up to 24 tonal sonobuoys (e.g., AN/SSQ-62) and two acoustic device countermeasures (ADCs) are also used per scenario. The number of passive sonobuoys (AN/SSQ-53D/E) deployed can vary. These scenarios continue over a 5 to 7 day period and occur four times per year. This training exercise using the AN/AQS-13 or AN/AQS-22 sonar systems would occur in the deep water OPAREAs off the coast of Jacksonville, Florida. To meet the operational requirements for the maximum distance from homeport, the western boundary (i.e., training area entry point) of the SEASWITI training area must be no greater than 167 kilometers (km) and 185 km (90 nautical miles [NM] and 100 NM) from port.

2.3.2.2 Group Sail

The Group Sail is a coordinated training scenario with one submarine and either two DDGs or one CG, one DDG, and one FFG. The ships and their embarked helicopters conduct ASW localization training using the AN/SQS-53, AN/SQS-56, and AN/AQS-13 or AN/AQS-22 dipping sonar. The submarine also periodically operates the AN/BQQ-10 sonar. Four tonal sonobuoys and two ADCs may also be used per scenario. The number of passive sonobuoys (AN/SSQ-53D/E) deployed can vary. In addition, up to two MK-48 torpedoes could be fired per exercise. These scenarios last from 2 to 3 days and occur 20 times per year. These events would be taking place within and seaward of the Virginia Capes (VACAPES), Cherry Point (CHPT), and Jacksonville/Charleston (JAX/CHASN) OPAREAs.

2.3.2.3 Integrated ASW Course

The Integrated ASW Course (IAC) is a tailored course of instruction designed to improve Sea Combat Commander (SCC) and Strike Group integrated ASW warfighting skill sets. Key components for this course of instruction include coordinated ASW training for the SCC or ASW Commander and staff, key shipboard decision makers, and ASW watch teams. IAC consists of two phases, IAC Phase I and IAC Phase II. IAC Phase I is an approved Navy course of instruction consisting of five days of basic and intermediate level classroom training. IAC Phase II is intended to leverage the knowledge gained during IAC Phase I and build the basic ASW coordination and integration skills of the Strike Group ASW Team. IAC Phase II is a coordinated training scenario that typically involves three DDG’s, one CG and one FFG, two to three embarked helicopters, one submarine, and one MPA aircraft searching for, locating, and attacking one submarine. The scenario consists of two 12-hour events that occur five times per year. While the ships are searching for the submarine, the submarine may practice simulated attacks against the ships. The ships and their embarked helicopters conduct ASW localization training using the AN/SQS-53, AN/SQS-56, and AN/AQS-13 or AN/AQS 22 dipping sonar. The submarines also periodically operate the AN/BQQ-10 sonar. Approximately 36 tonal sonobuoys may also be used per event. Multiple acoustic sources may be active at one time. These events would occur within and seaward of the VACAPES, CHPT, and JAX/CHASN OPAREAs or within and adjacent to the GOMEX OPAREA. During these exercises, some activities may occur in more than one OPAREA.

2.3.2.4 Submarine Command Course Operations

This scenario is conducted as training for submarine Executive and Commanding Officers, and involves two submarines conducting ASW training. The AN/BQQ-10 sonar is used, as well as four ADCs per scenario. In addition, up to 36 MK-48 torpedoes could be fired during the duration of an exercise. The SCC Operations scenario occurs two times per year and lasts from 3 to 5 days. This training exercise would be occurring in the JAX/CHASN and Northeast OPAREAs in deep ocean areas. Since targets may be employed, a support vessel may be required. This limits the western edge of the exercise boundary to within 148 km (80 NM) of a support facility.

2.3.2.5 Squadron Exercise and Gulf of Mexico Exercise

The scenario employs from one to five MCM ships conducting mine localization training. The AN/SQQ-32 and AN/SLQ-48 sonars are utilized. These scenarios are 10 to 15 days in length and occur four times per year. Either the Squadron Exercise (RONEX) or GOMEX Exercise would be conducted in both deep and shallow water training areas within and adjacent to the Pensacola and Panama City OPAREAs in the northern Gulf of Mexico.

2.3.3 Strike Group Training

The Expeditionary Strike Group (ESG) and Carrier Strike Group (CSG) consist of multiple ships, aircraft and submarines operating as an integrated force. Only those platforms that use active sonar are described in the following subsections. A typical ESG or CSG consists of up to six surface ships, one to five aircraft, and one submarine, approximately half of which are not equipped with active sonar sensors.

2.3.3.1 Composite Training Unit Exercise

The Composite Training Unit Exercise (COMPTUEX) is a training scenario designed to provide coordinated training to the entire ESG and CSG. An ESG COMPTUEX consists of a U.S. Navy ESG and U.S. Marine Corps units conducting integrated maritime and amphibious operations. ESG COMPTUEXs include the insertion of amphibious forces onto a beach, movement of vehicles and troops over land, delivery of troops and equipment from ship to shore via helicopters and fixed-wing MPA, the use of live-fire and blank munitions from ground-based troops and aircraft, and ship operations. In addition, Navy ships provide indirect Naval Surface Fire Support in support of the landing amphibious forces utilizing non-explosive ordnance. A

CSG COMPTUEX is a major at-sea training event that represents the first time before deployment that an aircraft carrier and its carrier air wing integrate operations with surface and submarine units in an at-sea environment. The ESG and CSG consist of multiple ships, aircraft and submarines operating as an integrated force. A typical ESG or CSG consists of up to six surface ships, one to five aircraft, and one submarine, approximately half of which are not equipped with active sonar sensors.

Sonars employed in this scenario include the AN/SQS-53, AN/SQS-56, AN/AQS-13 or AN/AQS-22 dipping sonar, and the AN/BQQ-10 sonar. Up to 218 tonal sonobuoys (e.g., AN/SSQ-62), 28 explosive source sonobuoys (AN/SSQ-110A), 5 receiver sonobuoys (AN/SSQ-101), and four ADCs are used per scenario. The number of passive sonobuoys (AN/SSQ-53D/E) deployed can vary. Each COMPTUEX lasts 21 days and occurs five times per year. These exercises would be conducted within and seaward of the VACAPES, CHPT, and JAX/CHASN OPAREAs, or within and adjacent to the GOMEX OPAREA. During these exercises, some activities may occur in more than one OPAREA.

2.3.3.2 Joint Task Force Exercise

The Joint Task Force Exercise (JTFEX) is the final fleet exercise prior to the deployment of the CSG and ESG. Specifically, a JTFEX would be scheduled after a CSG COMPTUEX to certify that the Strike Group is ready for deployment. The focus of a JTFEX is on mission planning and strategy and on the orchestration of integrated maneuvers, communication, and coordination. The activity is a non-scripted scenario-driven exercise that requires adaptive mission planning by participating naval forces and operational staff, and typically includes other DoD services and/or Allied forces. Often a CSG COMPTUEX and a JTFEX take place concurrently, in which case the exercise is called a Combined CSG COMPTUEX/JTFEX.

Typically, four DDGs, two FFGs, and three submarines participate in a JTFEX. Sonars employed in this scenario include the AN/SQS-53, AN/SQS-56, AN/AQS-13 or AN/AQS-22 dipping sonar, and the AN/BQQ-10 sonars. Up to 174 tonal sonobuoys (e.g., AN/SSQ-62), 28 explosive source sonobuoys (AN/SSQ-110A), five receiver sonobuoys (AN/SSQ-101), and 2 ADCs are used per JTFEX. The number of passive sonobuoys (AN/SSQ-53D/E) deployed can vary. The scenario lasts 10 days and occurs two times per year. JTFEX activities would be occurring in shallow and deep water portions located within and seaward of the VACAPES, CHPT, and JAX/CHASN OPAREAs.

2.3.3.3 Sustainment Training

Sustainment training consists of a variety of training evolutions designed to sustain warfighting readiness as a group, multi-unit, or unit until and following employment. Sustainment training, in port and at sea, allows forces to demonstrate proficiency in operating as part of a joint and coalition combined force and ensures that proficiency is maintained in order to maintain Major Combat Operations (MCO) Ready. The extent of the sustainment training will vary depending on the unit's length of time in a MCO Ready status, as well as the anticipated tasking. During sustainment training, units/groups maintain a MCO Ready status until the commencement of the maintenance phase, unless otherwise directed by the Fleet Commander. Unit/group integrity during this period is vital to ensure integrated proficiency is maintained. This is especially vital for strike groups.

2.3.4 Maintenance

2.3.4.1 Surface Ship Sonar Maintenance

This scenario consists of surface ships performing periodic maintenance to the AN/SQS-53 or AN/SQS-56 sonar while in port or at sea. This maintenance takes up to 4 hours. Surface ships would be operating their active sonar systems for maintenance while in shallow water near their

homeport, located in either Norfolk, Virginia or Mayport, Florida. However, sonar maintenance could occur anywhere as the system's performance may warrant.

2.3.4.2 Submarine Sonar Maintenance

A submarine performs periodic maintenance on the AN/BQQ-10 and AN/BQS-15 sonar systems while in port or at sea. This maintenance takes from 45 minutes to 1 hour. Submarines would conduct maintenance to their sonar systems in shallow water near their homeport of either Groton, Connecticut; Norfolk, Virginia; or Kings Bay, Georgia. However, sonar maintenance could occur anywhere as the system's performance may warrant.

2.3.5 RDT&E

For the purposes of analyzing RDT&E activities, active sonar usage has been rolled into representative ULT events (refer to Table 2-2).

2.3.6 Torpedo Exercise Areas

Torpedo firing activities would be occurring within the VACAPES and GOMEX OPAREAs, and within and seaward of the Northeast OPAREA. Due to operational requirements for torpedo recovery operations, support facilities must be located within 148 km (80 NM) of the torpedo exercise area.

2.4 OPERATIONAL REQUIREMENTS

The Navy needs to conduct Independent ULT, Coordinated ULT, and Strike Group training exercises, to include ASW and MIW active sonar operations, RDT&E, and active sonar maintenance activities. These activities occur at multiple locations along the East Coast and in the Gulf of Mexico. Conducting active sonar activities in multiple locations is necessary to ensure that the range of environments and features likely to be encountered in an actual conflict are experienced during training.

The Navy's operational requirements include the following:

- **Realistic training environment requirements** – the ability to conduct real world training.

- **Year-round opportunities** – the ability to conduct ASW, MIW, and RDT&E active sonar activities year-round.
- **Proximity to homeports** – the maximum operational distance feasible between homeport and training location. This requirement is driven by both platform and crew.
- **Coordinated sea and air space** – ensures the appropriate scheduling and deconflicting of military and civilian activities.
- **Training area size** – the minimum size of the training area necessary to provide adequate and safe training capabilities, as well as multi-unit active sonar activities.
- **Water depth** – the minimum safe water depth for each platform.
- **Proximity to support facilities** – the maximum operational distance feasible between support facilities and Strike Group training and RDT&E activity locations. This includes ranges, amphibious assault locations, and device recovery for Strike Group training and support personnel, equipment, and device deployment and recovery for RDT&E activities.
- **Acoustic environment** – properties that may affect the transmission and reception of underwater sound.
- **Target availability** – the ability to obtain, lay, and recover targets for select activities.

2.4.1 Universal Operational Requirements

The first four operational requirements listed in the preceding section apply generally to all active sonar activities, all alternatives, and are discussed in the four sections below.

2.4.1.1 Realistic Training Environment Requirements

Realistic training is essential to prepare and protect Sailors. Effective training requires conditions that mirror realistic combat scenarios for participating units. Naval personnel must also train using the combat tools that would be used during a conflict. For example, the nature of the littoral (shallow and/or near shore) waters where submarines can operate is complex. These areas are frequently confined, congested water and air space, making identification of allies, adversaries, and neutral parties more challenging than in open ocean.

2.4.1.2 Year-Round Training

The ability to train year-round is required if the Navy is to meet the requirements and schedules associated with the FRTP and the Fleet Response Plan (FRP), which includes meeting potential surge situations (i.e., immediate deployment of forces). The Navy is required under the FRP to have five or six CSGs ready to deploy within 30 days of notification and an additional one or two CSGs ready to go within 90 days. In order to meet this requirement, the Navy must have year-round access to training areas to ensure that a sufficient number of certified units are ready to be deployed at any given time.

2.4.1.3 Proximity to Homeports/Air Stations

Proximity to homeports/airbases is an important consideration based on time Navy personnel are away from home, fuel requirements of Navy vessels, and safety requirements for Navy aircraft. If ships and helicopters are to train in the same area, then the distance to the training area entry point must be based on the limited travel distance of the helicopter. Moreover, shorter transits between the training area and the homeport maximize training time and reduce operating costs and personnel deployment time. Keeping transit distances short is critical for submarines and surface ships due to their slower speeds and greater operating costs compared to aircraft.

Along the East Coast, the Fleet's primary homeports for surface ships are Norfolk, Virginia, and Mayport, Florida. In addition, a small number of surface ships are homeported at Portsmouth, New Hampshire; Little Creek, Virginia; and Ingleside, Texas. Navy submarine homeports located along the East Coast include Norfolk, Virginia; Groton, Connecticut; and Kings Bay, Georgia.

Helicopter airspeed and maximum flight duration necessitate that the training area entry point for dipping sonar training activities must be located within 7 km (4 NM) of the airfield, at which the helicopter is based. This equates to an on-station flight time of approximately one hour, with a reserve flight time of an additional one hour. ASW helicopters participating in training are stationed in Mayport, Florida and Norfolk, Virginia. This geographic limitation does not apply to helicopters embarked on a unit at sea.

MPA can fly faster and farther than helicopters. These aircraft are stationed at Brunswick, Maine; Patuxent River, Maryland; and Jacksonville, Florida. Crews stationed at each of these bases would use the proposed ASW training areas, as well.

In addition, torpedo exercise (TORPEX) activities are required to be conducted near a support facility equipped to assist in the recovery of fired exercise torpedoes. RDT&E activities are also typically conducted within close proximity to a shore side support facility equipped with the personnel and equipment required to deploy and recover test systems and targets.

Specifically, the majority of the MIW RDT&E activities would be conducted on the shelf within the GOMEX OPAREA. The majority of the ASW RDT&E would occur within the VACAPES and Northeast OPAREAs adjacent to Naval Air Station Patuxent River and the Naval Undersea Warfare Center, Newport facilities.

2.4.1.4 Coordinated Sea and Air Space

Active sonar training requires the use of sea and air space. The Navy must ensure safety; thus the military must conduct its activities to prevent conflicts with other aircraft and vessels in the vicinity. OPAREAs and Warning areas provide the ability for the Navy to schedule coordinated sea and airspace respectively. Refer to Section 3.14, Airspace Management, for additional information.

2.4.2 Operational Requirements According to each Active Sonar Activity

The remaining five operational requirements listed in the introductory paragraph are discussed in subsequent sections as they apply for each active sonar activity. Specific operational requirements for active sonar activities are summarized in sub-sections 2.4.2.1 through 2.4.2.8.

2.4.2.1 Littoral ASW Independent ULT

Littoral ASW training activities associated with surface ships' fixed-wing MPA (P-3), submarines and ASW helicopters require water depths ranging from 30 to 305 meters (m) (98 to 1,001 feet [ft]). The bottom contours must be smooth; a sand-silt-clay bottom is preferred.

ASW ULT activities occurring in shallow waters may include up to two ships searching and tracking a target submarine. In some instances, the training requires a helicopter equipped with dipping sonar be deployed to track the target. In more complex ULT activities, a fixed-wing MPA is required to deploy sonobuoys to assist the surface unit in prosecuting the target submarine. Under ordinary conditions, the nominal required training area for littoral ASW Independent ULT activities is 111 km x 167 km (60 NM x 90 NM) rectangular area. The overall training area might need to be larger to ensure sufficient space is available under the environmental conditions of the day to replicate a realistic training environment, ensuring the necessary operational flexibility during all training conditions that may be encountered. Littoral ASW ULT will also require the use of one or more targets, which might consist of one or more submarines, one or more unmanned targets, or a combination of the two. Where unmanned targets are used, littoral ASW training must be conducted in an area where targets can be deployed and recovered following an activity.

2.4.2.2 Open-Ocean ASW Independent ULT

Open-ocean ASW Independent ULT activities associated with surface combatants' fixed-wing MPA, submarines, and ASW helicopters require water depths greater than 366 m (1,200 ft). The open ocean ASW Independent ULT training activities require access to a variety of bottom and bathymetry types to simulate similar environmental conditions that could potentially be encountered during an actual wartime scenario.

ASW ULT activities occurring within the open ocean require one to two ships searching and tracking a target submarine. In some instances, the training might require that a helicopter equipped with dipping sonar be deployed to track the target. In more complex ULT activities, fixed-wing aircraft are required to deploy sonobuoys to assist the surface unit in prosecuting the target submarine. Under ordinary conditions, the nominal required training area for these ASW Independent ULT activities is 111 km x 241 km (60 NM x 130 NM) rectangular area. The overall training area might need to be larger to ensure sufficient space is available under the environmental conditions of the day to replicate a realistic training environment, thus ensuring the necessary operational flexibility during all training conditions that might be encountered. Open-ocean ASW ULT will also require the use of one or more targets, which might consist of one or more submarines, one or more unmanned targets, or a combination of the two. Where unmanned targets are used, littoral ASW training must be conducted in an area where targets can be deployed and recovered following an activity.

2.4.2.3 MIW Independent ULT

MIW Independent ULT activities occur in the GOMEX, JAX/CHASN, and VACAPES OPAREAs and involve submarines, helicopters, and surface ships. The MIW Independent ULT training activities require access to bottom types and bathymetry suitable for targets (i.e., no hard bottom areas).

MIW Independent ULT activities require water depths from 5 to 40 m (16 to 131 ft). Under ordinary conditions, the required nominal training area for these MIW Independent ULT activities is a 111 km x 148 km (60 NM x 80 NM) rectangular area. The overall training area might need to be larger to ensure sufficient space is available under the environmental conditions of the day.

2.4.2.4 Object Detection/Navigational Sonar Independent ULT

Object detection/navigational Independent ULT activities are required for surface ships and submarines (i.e., DDGs, FFGs, CGs, nuclear powered attack submarines [SSNs], and nuclear guided missile submarines [SSGNs]) leaving and returning to homeport. Ships leaving and entering homeport conduct navigational Independent ULT activities only 20 percent of the time.

Norfolk, Virginia, and Mayport, Florida, homeports require areas for surface ship object detection (Kingfisher) Independent ULT activities. Kings Bay, Georgia, Norfolk, Virginia, and Groton, Connecticut require areas for submarine navigational Independent ULT activities. The object detection/navigational Independent ULT activities occurring at each homeport occur from port and follow the shipping lanes and submarine transit lanes out into open water.

Object detection sonar training areas for surface ships using the AN/SQS-53 or AN/SQS-56 object detection modes require existing shipping lanes and channels used to access both Norfolk, Virginia and Mayport, Florida. The required training area for object detection sonar was determined to be a 7 km (4 NM) wide swath of water beginning in port and following the shipping lanes out to open water.

Submarine navigational sonar training areas require the submarine lanes used for entering and departing Groton, Connecticut; Norfolk, Virginia; and Kings Bay, Georgia. Under ordinary conditions, the required training area for submarine navigational sonar was determined to be a 7 km (4 NM) wide swath of water beginning in port and following the submarine transit lanes out to open water. The overall training area may need to be larger to ensure sufficient space is available under the environmental conditions of the day.

2.4.2.5 Coordinated MIW and ASW ULT

Coordinated ULT activities require both shallow- and deep-water access with water depths of 30 m (98 ft) and deeper. Platforms participating in these training activities include surface ships (i.e., DDGs, FFGs, and CGs), fixed-wing MPA, submarines, and ASW helicopters. Coordinated ULT activities require access to a variety of bottom types and bathymetry including areas of low bottom loss (a bottom area with low potential for sound absorption), surface ducts (a near-surface layer that traps sound energy), and geographical attributes that facilitate bottom bounce (a hard, sediment based bottom) and that are in close proximity to the Gulf Stream. For instance, the Gulf Stream near the Cape Hatteras, North Carolina region separates the continental slope from the deep ocean, and from the point where southward flowing continental shelf water from the Middle Atlantic Bight converges with northward flowing continental shelf water from the South Atlantic Bight. These training activities require training areas that replicate the conditions under which actual combat could occur.

Coordinated ASW ULT activities require a 111 km x 241 km (60 NM x 130 NM) training area, in order to provide sufficient sea space to conduct exercises with up to four ships along the East Coast and within the Eastern Gulf of Mexico.

Coordinated MIW ULT training requires up to five surface ships, one helicopter, and various UUV packages. Two of the MIW Coordinated ULT activities, GOMEX exercises and RONEX, require a 37 km x 37 km (20 NM x 20 NM) training area. The overall training area may need to be larger to ensure sufficient space is available under the environmental conditions of the day.

Coordinated ULT activities require proximity to exercise support infrastructure, such as land ranges and access to amphibious beachheads. Similarly, the proximity and availability to one or more submerged targets is required. Furthermore, TORPEX activities require the use of a target; therefore, TORPEX activities must be conducted in an area where targets are readily available, or can be deployed and recovered following an event.

2.4.2.6 Strike Group Training Exercises

Strike Group training exercises require both shallow- and deep-water access, with water depths of 30 m (98 ft) and deeper. Platforms participating in these training activities include surface combatants (i.e., DDGs, FFGs, and CGs), fixed-wing MPA, submarines, and ASW helicopters. Strike Group training exercises also require access to a variety of bottom types and bathymetry including areas of low bottom loss, surface ducts, and geographical attributes that facilitate bottom bounce and that are in close proximity to the Gulf Stream. These training activities require training areas that replicate the conditions under which actual combat could occur.

Strike Group training requires up to two strike groups along the East Coast and within the eastern Gulf of Mexico. The Strike Group training activities require a 148 km x 222 km (80 NM × 120 NM) training area to accommodate unscripted freeplay scenarios. These unscripted scenarios attempt to reduce training artificiality that might provide one side an advantage. The overall training area might need to be larger to ensure sufficient space is available under the environmental conditions of the day.

Proximity to exercise support infrastructure, such as land ranges and access to amphibious beachheads, are required for Strike Group training where exercises are likely to contain a number of coordinated activities that simulate a real-world battle scenario. In addition, training that uses an aircraft carrier must be located within 167 to 222 km (90 to 120 NM) of an airfield for emergency jet aircraft landing.

2.4.2.7 RDT&E Activities

RDT&E activities require proximity to a shore support facility with the personnel and equipment required to deploy and recover test systems and targets. Specifically, the majority of the MIW RDT&E activities would be conducted on the shelf within the northern portion of the GOMEX

OPAREA, offshore of Naval Surface Warfare Center, Panama City Division (NSWC PCD). In addition, the majority of the ASW RDT&E would occur within the VACAPES and Northeast OPAREAs adjacent to Naval Air Station Patuxent River and the Naval Undersea Warfare Center, Newport, facilities. The water depth and environmental conditions required are dependent on the system undergoing developmental tests (DTs) or operational tests (OTs). RDT&E water depth requirements can vary depending on the system being tested and typically range from 2 to 610 m (7 to 2,001 ft) in depth. The area required for RDT&E activities can vary depending on the system being tested and the overall objective of the given test.

2.4.2.8 Active Sonar Maintenance

Active sonar maintenance activities associated with surface combatant and submarine hull-mounted sonars are typically conducted pier side prior to deployment or while in transit to training. Thus, specific water depth and area requirements do not constrain these activities.

2.5 ALTERNATIVES CONSIDERED BUT ELIMINATED FROM FURTHER ANALYSIS

The operational requirements discussed in Section 2.4 are used as the screening criteria. The alternatives discussed in subsequent sections were considered but were not reasonable because they did not meet one or more of the screening criteria.

2.5.1 Conduct No Active Sonar Activities

Conducting training exercises along the East Coast or in the Gulf of Mexico without the use of active sonar the Navy would not be able to meet its statutory obligations, as identified in Title 10 United States Code, Section 5062, which requires the Navy to be “organized, trained, and equipped primarily for prompt and sustained combat incident to operations at sea.” Without use of active sonar, U.S. combat forces would not be capable of deploying at a level of readiness necessary to respond to “real world” contingency situations as have recently occurred in the eastern Mediterranean and the Arabian Sea, or potential future threat situations in the China Sea and Sea of Japan. Additionally, RDT&E supports the Title 10 mandate because it provides the Navy the capability of developing new active sonar systems and ensuring their safe and effective implementation for the Atlantic Fleet.

2.5.2 Utilization of U.S. West Coast Training Areas

Units need to be stationed on both coasts to respond to contingencies and be available to combatant commanders world-wide. West Coast training areas would not be reasonable for training Atlantic Fleet units because of the extreme transit distance, excessive costs, and time constraints that would be involved. Crew training needs to be conducted on the specific ship to which they are assigned. It is important that the crew being trained become familiar with the ship they operate. Therefore, if training were to be conducted on the West Coast, the entire crew and ship would need to make the trip over in order to maintain the same level of ASW and MIW proficiency.

2.5.3 All Active Sonar Activities Conducted through Simulation

Currently, computer modeling simulations cannot adequately mimic the bathymetry, sound propagation properties, or oceanography to the degree necessary to serve as a substitute for actual at-sea sonar operations. Simulators will not replace real-world training in the foreseeable future since simulators cannot provide the dynamic and vastly challenging scenarios that are encountered in the ocean environment. Therefore, conducting all activities through simulation does not meet the operational requirements of realistic training (Section 2.4.1.1).

Active sonar training includes extensive use of computer-simulated virtual training environments, and conducts command and control exercises without operational forces (constructive training) where possible. These training methods have substantial value in achieving limited training objectives. Computer technologies provide excellent tools for implementing a successful, integrated training program while reducing the risk and expense typically associated with live military training. However, virtual and constructive training are an adjunct to, not a substitute for, live training. Unlike live training, these methods do not provide the requisite level of realism necessary to attain combat readiness, and cannot replicate the high-stress environment encountered during an actual contingency situation.

The Navy continues to research new ways to provide realistic training through simulation, but there are limits to realism that simulation can provide, most notably in dynamic environments involving numerous forces, and where the training media is too complex to accurately model, such as sound behavior in the ocean.

Current simulation technology does not permit ASW training with the degree of fidelity required to maintain proficiency. Basic training of sonar technicians does take place using simulators, but beyond basic levels, simulation is of limited utility. A simulator cannot match the dynamic nature of the environment, either in bathymetry, sound propagation properties, or oceanography. Specifically, Coordinated ULT and Strike Group Training activities require multiple crews to interact in a variety of acoustic environments that cannot be simulated. Moreover, it is a training imperative that crews actually utilize the equipment they will be called upon to operate. In addition, the majority of RDT&E activities also must be conducted in a variety of acoustic environments to ensure the safe and effective use of the active sonar system.

Sonar operators and crews must train regularly and frequently to develop the skills necessary to master the process of identifying underwater threats in the complex subsurface environment. They cannot reliably simulate this training through current computer technology because the actual marine environment is too complex. Sole reliance on simulation would deny Navy Strike Groups the training benefit and opportunity to derive critical lessons learned in the employment of active sonar in the following specific areas:

- Bottom bounce and multiple propagation path environmental conditions,
- Mutual sonar interference,
- Interplay between ship and submarine target, and
- Interplay between ASW teams in the strike group.

Currently, these factors cannot be adequately simulated to provide the fidelity and level of training necessary in the employment of active sonar. Further, like any combat skill, employment of active sonar is a perishable skill that must be exercised in a realistic and integrated manner in order to maintain proficiency. Eliminating the use of active sonar during the training cycle would cause ASW skills to atrophy and thus put U.S. Navy forces at risk during real world operations. Moreover, conducting all activities through simulation does not meet the operational requirements of realistic training (Section 2.4.1.1).

Consequently, conducting all naval training by simulation is deemed inadequate as it fails to meet the purpose and need of the Proposed Action. Therefore, this alternative was eliminated from further study and analysis.

2.5.4 Restricting Active Sonar Use by Season over Large Geographic Regions

The Navy has established policy governing the composition and required mission capabilities of deployable naval units, focused on maintaining flexibility in the organization and training of forces. Central to this policy is the ability of naval forces of any size to operate independently, or to merge into a larger naval formation to confront a diverse array of challenges. Training requirements are determined by a number of factors, including the composition of the force to be trained, the nature of its mission upon deployment, the time available to conduct training, and the commander's assessment of training priorities. Accommodating factors such as these in the context of the Navy's national security mission is a complex undertaking that requires continuous planning and the flexibility to execute a broad spectrum of events at any given time in any given location.

As discussed previously, active sonar training is governed by the Navy's FRTP. The FRTP is the Navy's training plan that requires naval forces to develop warfare skills in preparation for operational deployment and to maintain a high level of proficiency and readiness while deployed. As such, the FRTP sets the deployment training for Strike Groups, which are continuously deployed to provide a global naval presence, and must also be ready to "surge" on short notice in response to directives from the National Command Authority.

Active sonar activities described in this EIS/OEIS could include multiple simultaneous activities involving vessels and helicopters stationed out of geographically separate homeports. However, since the training schedule is driven by the deployment schedule, active sonar activities must be conducted year-round and in multiple locations to ensure that the range of environments and features likely to be encountered in an actual conflict are experienced during training. As discussed in Section 2.4, locations where active sonar activities could occur are limited by nine operational criteria. Therefore, no one OPAREA, or area adjacent to OPAREAs within the AFAST Study Area, can be avoided.

Any restriction of active sonar activities during certain seasons over large geographic regions would not allow the Navy to comply with the FRTP, and world-wide presence requirements would not be met. For this reason, alternatives that would not meet the operational requirements described in Section 2.4 would not meet the purpose and need of the Proposed Action, and therefore, were eliminated from further study and analysis.

2.5.5 Altering the Tempo and Intensity of Atlantic Fleet Active Sonar Training

The Navy's requirement for training have been developed through many years of iteration to ensure Sailors achieve levels of readiness to ensure they are prepared to properly respond to the many contingencies that may occur during an actual mission. These training requirements are designed to provide the experience and proficiency needed to ensure Sailors are properly prepared for operational success. There is no "extra" training built into the Navy training program.

Based on extensive discussion within the operational community, the Atlantic Fleet does not presently anticipate that an increase in active sonar activities is needed to fulfill mission requirements described in this document nor that a decrease in the intensity of operations would fulfill those same operational requirements. Any reduction of training would not allow the Navy to achieve satisfactory levels of proficiency and readiness required to accomplish assigned missions. For this reason, alternatives that would alter the tempo or intensity would not meet the purpose and need of the Proposed Action, and therefore, were eliminated from further study and analysis.

2.6 ALTERNATIVES INCLUDED FOR ANALYSIS

The alternatives described in this section represent a full range of options that meet all of the above screening criteria. Under Alternative 1, Designated Active Sonar Areas, fixed active sonar areas would be designated using an environmental analysis to determine locations that would minimize environmental effects to biological resources while still meeting training requirements. These areas would be available for use year-round. Under Alternative 2, Designated Seasonal Active Sonar Areas, active sonar training areas would be designated using the same environmental analysis conducted under Alternative 1. The areas would be adjusted seasonally to minimize effects to marine resources while still meeting minimum operational requirements. Under Alternative 3, Designated Areas of Increased Awareness, the results of the environmental analysis conducted for Alternative 1 and 2 were utilized in conjunction with a qualitative environmental analysis of sensitive habitats to identify areas of increased awareness. Active sonar would not be conducted within these areas of increased awareness. Under the No Action Alternative, the Navy would continue conducting active sonar activities within and adjacent to existing OPAREAs rather than designate active sonar areas or areas of increased awareness. Under the No Action Alternative, Alternative 1, Alternative 2, and Alternative 3, the U.S. Navy does not plan to conduct active sonar activities within the Stellwagen Bank, Monitor, Gray's Reef, Flower Garden Banks, and Florida Keys National Marine Sanctuaries and will avoid these sanctuaries by observing a 5 km (2.7 NM) buffer. In the event the Navy determines AFAST activities, due to operational requirements, are likely to destroy, cause the loss of, or injure any sanctuary resource (for Stellwagen Bank National Marine Sanctuary, the threshold is "may" destroy, cause the loss of, or injure), the Navy would first consult with the Director, Office of National Marine Sanctuaries in accordance with 16 U.S.C. 1434(d).

2.6.1 No Action Alternative

The No Action Alternative (Figure 2-8) is to continue conducting active sonar activities within and adjacent to existing OPAREAs (i.e., throughout the AFAST Study Area) rather than designate active sonar areas or areas of increased awareness. The No Action alternative can be regarded as continuing with the present course of action. Under the No Action Alternative, active sonar activities occur in locations that maximize active sonar opportunities and meet applicable operational requirements associated with a specific active sonar activity. Currently active sonar training does not occur in North Atlantic right whale critical habitat with the exception of object detection and navigation off shore Mayport, Florida and Kings Bay, Georgia; helicopter ASW offshore Mayport, Florida; and TORPEXs in the northeast during August and September. Additionally, the U.S. Navy does not plan to conduct active sonar activities within the Stellwagen Bank, Monitor, Gray's Reef, Flower Garden Banks, and Florida Keys National Marine Sanctuaries under the No Action Alternative and will avoid these sanctuaries by observing a 5 km (2.7 NM) buffer. In the event the Navy determines AFAST activities, due to operational requirements, are likely to destroy, cause the loss of, or injure any sanctuary resource (for Stellwagen Bank National Marine Sanctuary, the threshold is "may" destroy, cause the loss of, or injure), the Navy would first consult with the Director, Office of National Marine Sanctuaries in accordance with 16 U.S.C. 1434(d). The following subsections describe the locations for specific training activities.

2.6.1.1 ASW Training Areas

ASW activities for all platforms could occur within and adjacent to existing East Coast OPAREAs beyond 22.2 km (12 NM) with the exception of sonar dipping activities, however, most ASW training involving submarines or submarine targets would occur in waters greater than 183 m (600 ft) deep due to safety concerns about running aground at shallower depths. ASW active sonar activities occurring in specific locations are discussed below.

2.6.1.1.1 Helicopter ASW ULT Areas

The helicopter ASW ULTs are the only ASW activity that could occur within 22 km (12 NM) of shore. This activity would be conducted by helicopters embarked on a surface ship in the waters of the East Coast OPAREAs. Helicopter ASW ULT events are also conducted by helicopters deployed from shore-based Jacksonville, Florida, units. These helicopter units use established sonar dipping areas offshore Mayport (Jacksonville), Florida, which are located in territorial waters and within the southeast North Atlantic right whale critical habitat.

2.6.1.1.2 SEASWITI Areas

This training exercise generally occurs within and seaward of the JAX/CHASN OPAREA.

2.6.1.1.3 Group Sail Areas

These events typically take place within and seaward of the VACAPES, CHPT, and JAX/CHASN OPAREAs.

2.6.1.1.4 Integrated ASW Course

IAC events typically take place within and seaward of the VACAPES, CHPT, and JAX/CHASN OPAREAs.

2.6.1.1.5 Submarine Command Course Operations Areas

This training exercise typically occurs in the JAX/CHASN and Northeast OPAREAs in deep ocean areas.

2.6.1.1.6 Torpedo Exercise Areas

TORPEX can occur anywhere within and adjacent to East Coast and GOMEX OPAREAs. The exception is in the Northeast OPAREA where the North Atlantic right whale critical habitat is located. TORPEX areas that meet current operational requirements for proximity to torpedo and target recovery support facilities were established during previous Endangered Species Act (ESA) Section 7 consultations with the National Marine Fisheries Service (NMFS). (Refer to Section 1.7.7 for additional information on previous consultations.) Therefore, TORPEX activities in the northeast North Atlantic right whale critical habitat are limited to these established areas.

2.6.1.2 MIW Training Areas

MIW Training could occur in territorial or non-territorial waters. Independent and Coordinated MIW ULT activities would be conducted within and adjacent to the Pensacola and Panama City OPAREAs in the northern Gulf of Mexico and off the east coast of Texas in the Corpus Christi OPAREA.

The RONEX or GOMEX Exercises would be conducted in both deep and shallow water training areas.

2.6.1.3 Object Detection/Navigational Training Areas

Surface Ship training would be conducted primarily in the shallow water port entrance and exit lanes for Norfolk, Virginia and Mayport, Florida. The transit lane servicing Mayport, FL crosses through the southeast North Atlantic right whale critical habitat.

Submarine training would occur primarily in the established submarine transit lanes entering/exiting Groton, Connecticut; Norfolk, Virginia; and Kings Bay, Georgia. The transit lane servicing Kings Bay, Georgia, crosses through the southeast North Atlantic right whale critical habitat.

2.6.1.4 Maintenance Areas

Maintenance activities could occur in homeports located in territorial waters, or in the open ocean within non-territorial waters.

2.6.1.4.1 Surface Ship Sonar Maintenance Areas

Surface ships would be operating their active sonar systems for maintenance while pier side within their homeports, located in either Norfolk, Virginia or Mayport, Florida. Additionally open ocean sonar maintenance could occur anywhere within the non-territorial waters of the AFAST Study Area as the system's performance may warrant.

2.6.1.4.2 Submarine Sonar Maintenance Areas

Submarines would conduct maintenance to their sonar systems pier side in their homeports of either Groton, Connecticut; Norfolk, Virginia; or Kings Bay, Georgia. Additionally, sonar maintenance could occur anywhere within the non-territorial waters of the AFAST Study Area as the system's performance may warrant.

2.6.1.5 RDT&E Areas

For RDT&E activities included in this analysis, active sonar activities occur in similar locations as representative training events.

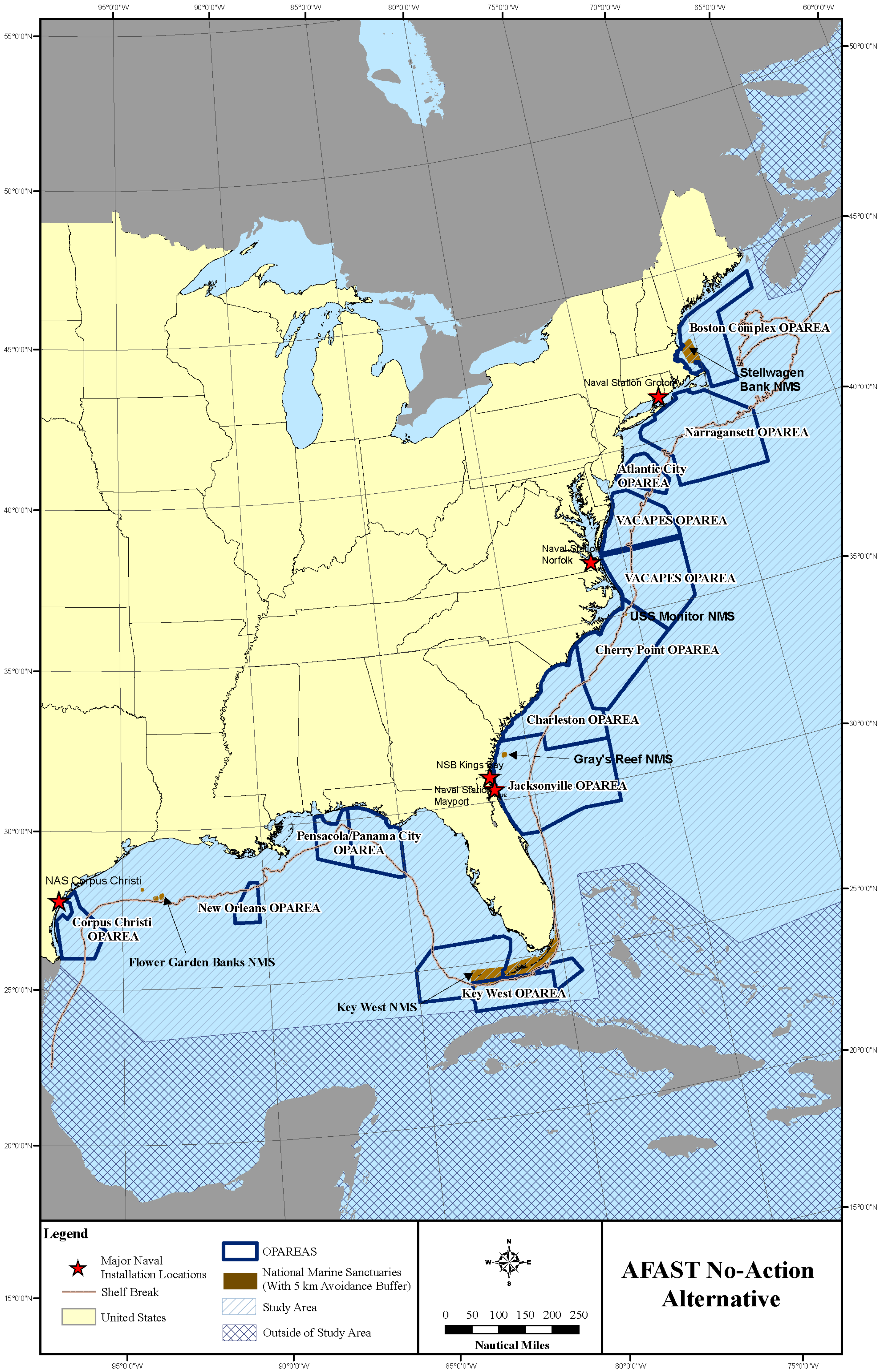


Figure 2-8. No Action Alternative – Active Sonar Activities could occur Anywhere in the Study Area

This page is intentionally blank.

2.6.2 Process for Development of Action Alternatives

When developing a reasonable range of alternatives, the Navy focused on the acoustic exposure of marine mammals because of public and regulatory concern regarding the potential effects of sonar on marine mammals. The Navy used the following process to develop and identify alternatives (refer to Appendix D for additional information):

(1) Define the operational requirements needed to effectively meet Navy training requirements. This was achieved using operator input for ASW and MIW training requirements, as well as information from Navy Systems Commands regarding RDT&E requirements.

(2) Use the requirements defined in Step 1 (e.g. the size of the area, the water depth, or the bottom type needed for a particular training event) to identify the feasible active sonar locations (Section 2.4).

(3) Using the locations identified in Step 2, a surrogate environmental analysis was conducted to analyze the sound exposures of marine mammals to 100 hours of AN/SQS-53 sonar. This surrogate analysis provided a comparison of the number of marine mammal exposures that would be estimated in a given area during a given season, providing a basis from which geographic and seasonal alternatives were developed for full analysis in this EIS/OEIS. The surrogate analysis allowed alternatives to be developed based on the potential to reduce the number of marine mammal exposures while supporting the conduct of required active sonar activities. These locations were carried forward as reasonable alternatives for analysis of all active sonar activities and sonar hours described in this EIS/OEIS (see Appendix D, Description of Alternative Development, for the acoustic modeling sound exposures estimated during the surrogate analysis).

(4) USFF was able to consider biological factors such as animal densities and unique habitat features because of geographic flexibility in conducting ASW training. USFF is not tied to a specific range support structure for the majority of the training. Additionally, the topography and bathymetry along the East Coast of the United States and in the Gulf of Mexico is unique in that there is a wide continental shelf leading to the shelf break affording a wider range of training opportunities.

Following identification of operational requirements associated with Step 1 of the alternative development process, feasible active sonar activity areas were delineated for specific types of active sonar activities (i.e. Step 2). The Navy then refined its possible areas by avoiding sensitive areas where feasible, while still meeting operational requirements (i.e. Step 3 and 4). Using a surrogate analysis, the Navy defined these sensitive areas as having relatively greater potential for marine mammal exposure to sonar. Specifically, this surrogate analysis provided a relative comparison of the number of marine mammal exposures that would be estimated in a given area during a given season, and provided a basis from which geographic and seasonal alternatives were developed as will be discussed in the following paragraphs. The Navy further assumed that all active sonar activities conducted within the designated areas would utilize the mitigation measures detailed in Chapter 5.

Throughout the AFAST Study Area, marine mammal densities and the acoustic environment characteristics were combined in a series of maps (Appendix D, Description of Alternatives

Development) to show in which areas sonar activities would be more or less likely to result in exposures to marine mammals.. Maps for the following marine mammals were generated using seasonal densities:

- Beaked whales
- North Atlantic right whales
- Sperm whales
- Combined odontocetes (toothed whales)
- Combined mysticetes (baleen whales)
- Marine Mammal Protection Act (MMPA) species, including beaked whales, North Atlantic right whales, and sperm whales
- Endangered Species Act (ESA) marine mammal species, including the North Atlantic right whales, and sperm whales

The acoustic environment determines how sound travels through the water and depends on a variety of factors including temperature [seasonal variations], depth, geologic features, etc. (refer to Appendix D, Description of Alternatives Development, for additional information). The relative marine mammal exposure maps (Figure 2-9 depicts an example for one species during one season) were developed by dividing the Study Area into 10 km x 10 km (5.4 NM x 5.4 NM) grids and estimating the number of marine mammals exposed to a standardized amount of sonar use in each grid. Potential for exposure was developed by the following formula:

acoustic environment x marine mammal density = potential for exposure

The Navy used these maps for the purpose of identifying areas of low marine mammal exposures that meet the operational requirements. The Navy used all of the maps listed above to identify areas of high and low likelihood of exposures; however, due to their ESA status or sensitivity to sound, beaked whale, North Atlantic right whale, and sperm whale densities were specifically used in the environmental analysis. Due to the well-published sensitivities that beaked whales exhibit to mid-frequency active sonar, beaked whale seasonal density graphics and exposure grids served as the primary data used to limit the placement of the training areas locations. Overall, the active sonar areas were placed to avoid or minimize effects to marine species within the larger, operationally feasible areas.

It should be noted that this analysis (detailed description provided in Appendix D) was used to develop the Action Alternatives; a detailed description of estimated exposures associated with active sonar activities is provided in Chapter 4.

The following subsections address active sonar activity locations with respect to the three action alternatives. These sections are arranged slightly different than those presented for the No Action Alternative as the No Action Alternative does incorporate geographic limitations.

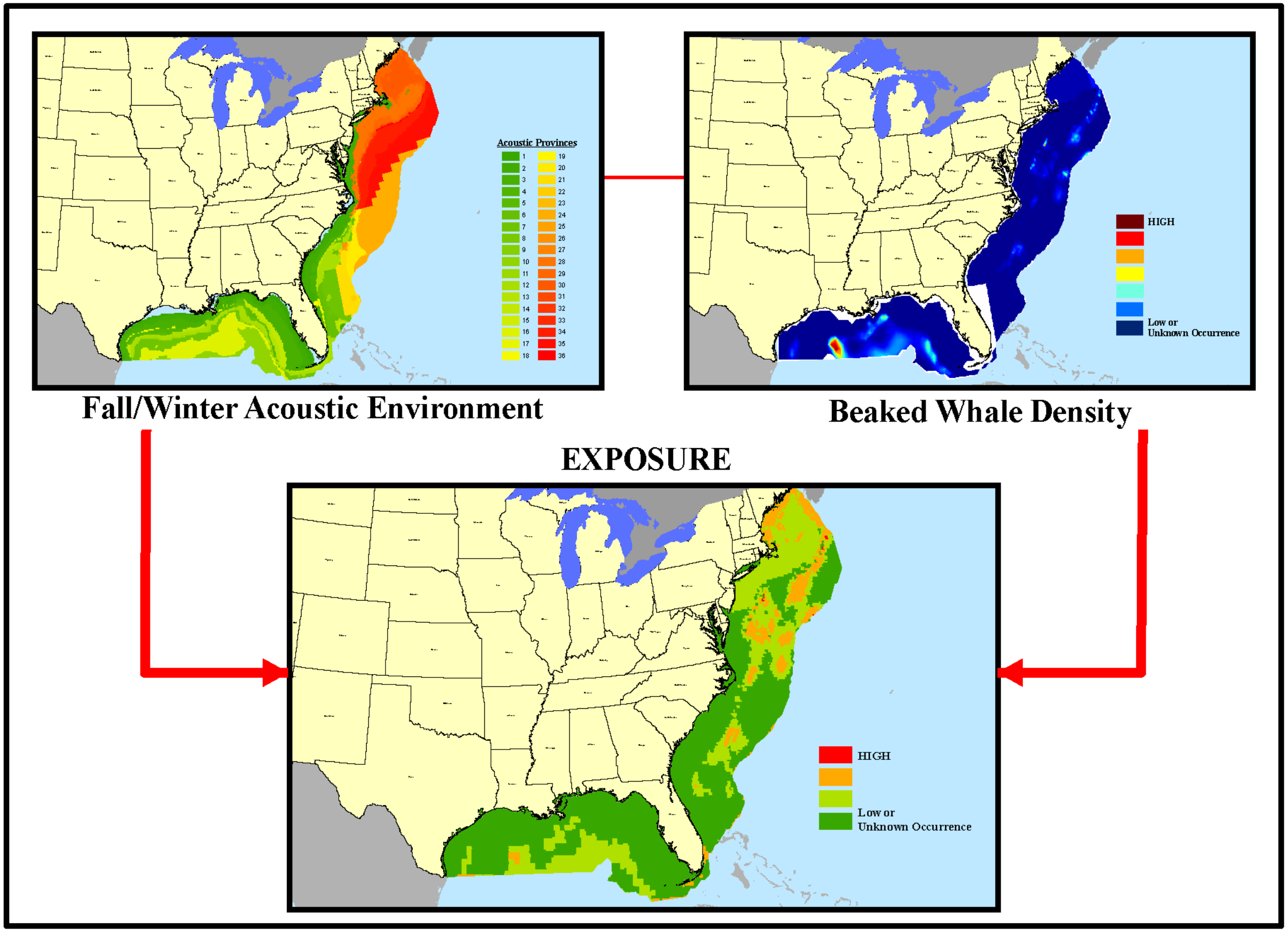


Figure 2-9. Flow Diagram Depicting How Maps Were Generated for Beaked Whale Exposures (Fall/Winter)

This page is intentionally blank.

2.6.3 Alternative 1 – Designate Active Sonar Areas

Alternative 1 designates fixed active sonar areas based on operational requirements and environmental analysis. Training fidelity would be accomplished by identifying optimal locations (Figures 2-10 through 2-13) based on replication of threat environments, proximity for multiple assets, safety of personnel, adequacy of training spaces, and availability of multiple training locations to support FRTP and surge. The trans-Atlantic routes associated with Navy vessel movements in and out of port would not change or be altered based on the development of this alternative. Additionally, the U.S. Navy does not plan to conduct active sonar activities within the Stellwagen Bank, Monitor, Gray's Reef, Flower Garden Banks, and Florida Keys National Marine Sanctuaries under the Alternative 1 and will avoid these sanctuaries by observing a 5 km (2.7 NM) buffer. In the event the Navy determines AFAST activities, due to operational requirements, are likely to destroy, cause the loss of, or injure any sanctuary resource (for Stellwagen Bank National Marine Sanctuary, the threshold is "may" destroy, cause the loss of, or injure), the Navy would first consult with the Director, Office of National Marine Sanctuaries in accordance with 16 U.S.C. 1434(d).

2.6.3.1 Independent ULT

2.6.3.1.1 Surface Ship ASW ULT

Under Alternative 1, surface ships would have the opportunity to conduct ASW training within any of the designated ASW training areas within and seaward of the Northeast, VACAPES, JAX/CHASN, CHPT, or GOMEX OPAREAs. Typically, training areas would be located near the homeports of Norfolk, Virginia and Mayport, Florida.

2.6.3.1.2 Surface Ship Object Detection/Navigational Sonar ULT

The Navy would conduct this training primarily in the shallow water shipping lanes off the coasts of Norfolk, Virginia and Mayport, Florida**.** The transit lane servicing Mayport, Florida crosses through the southeast North Atlantic right whale critical habitat.

2.6.3.1.3 Helicopter ASW ULT

Based on the distance requirement of 7 km (4 NM) for ASW helicopters to travel from their airbase in Mayport, Florida, there is very little flexibility in adjusting the location of the established dipping area. Therefore, the area used for shore-based ASW helicopter dipping sonar training in the No Action Alternative would become the designated ASW helicopter dipping training area for Alternative 1. This area is within the southeast North Atlantic right whale critical habitat. While ASW helicopters are embarked on ships they would use the designated shallow and deep ASW training areas to conduct this training.

2.6.3.1.4 Submarine ASW ULT

Navy submarines would have the opportunity to conduct shallow and deep water ASW training within any of the designated ASW training areas within and seaward of existing East Coast OPAREAs and within the GOMEX OPAREA.

2.6.3.1.5 Submarine Object Detection/Navigational Sonar ULT

Submarines use sonar for object detection and navigation while entering and leaving their homeports, primarily in the established submarine transit lanes outside of Groton, Connecticut; Norfolk, Virginia; and Kings Bay, Georgia. The transit lane servicing Kings Bay, Georgia, crosses through the southeast North Atlantic right whale critical habitat. These transit lanes would remain unchanged for Alternative 1.

2.6.3.1.6 Maritime Patrol Aircraft ASW ULT

Under Alternative 1, MPA would be able to conduct ASW training using sonobuoys (tonal [AN/SSQ-62], passive [AN/SSQ-53 or AN/SSQ-101], and explosive source sonobuoys [AN/SSQ-110A]) within any of the designated ASW training area within and seaward of existing East Coast OPAREAs and occasionally in the designated training areas within the GOMEX OPAREAs. For explosive source sonobuoys (AN/SSQ-110A), an additional training area in the eastern GOMEX OPAREA would be established (Figure 2-13).

2.6.3.1.7 Surface Ship MIW ULT

This training would be conducted in the designated training areas within the GOMEX OPAREA in the northern Gulf of Mexico and within the Corpus Christi OPAREA off the east coast of Texas.

2.6.3.2 Coordinated ULT

2.6.3.2.1 SEASWITI

The SEASWITI exercises would be conducted in one or more of the established ASW training areas within and seaward of the JAX/CHASN and CHPT OPAREAs. To meet the operational requirements for the maximum distance from homeport, the western boundary (i.e., training area entry point) of the SEASWITI training area was placed within 185 km (100 NM) of Mayport, Florida.

2.6.3.2.2 Torpedo Exercise

Torpedo firing exercises would be conducted during applicable ASW training exercises. Under Alternative 1, this training would be conducted in the designated ASW training areas within the VACAPES or GOMEX OPAREAs or in the designated TORPEX boxes within and adjacent to the Northeast OPAREA. All torpedoes fired during these training activities would be inert and recoverable. Since recovery operations are required, the exercise areas are required to be within an acceptable distance (i.e., less than 148 km [80 NM]) of a support facility equipped to assist in the recovery of fired exercise torpedoes. The designated TORPEX boxes within and adjacent to the Northeast OPAREAs are located within North Atlantic right whale critical habitat and were established under previous ESA Section 7 consultations with NMFS. (Refer to Section 1.7.7 for additional information on previous consultations.)

2.6.3.2.3 Group Sail

The Group Sail exercises would be conducted in one or more of the designated ASW training areas within and seaward of the VACAPES, JAX/CHASN and CHPT OPAREAs.

2.6.3.2.4 Integrated ASW Course

IAC events typically take place within and seaward of the VACAPES, CHPT, and JAX/CHASN OPAREAs.

2.6.3.2.5 Submarine Commander's Course Operations

SCC Operations occur in the designated ASW training areas within and seaward of the JAX/CHASN and Northeast OPAREAs. Support vessels may be required for this training activity since it would be conducted in deep ocean areas and targets may be employed. As such, the western edge of the exercise boundary must be within 148 km (80 NM) of a support facility.

2.6.3.2.6 Squadron Exercise and Gulf of Mexico Exercise

The RONEX/GOMEX Exercises would be conducted in the ASW training area within and seaward of the GOMEX OPAREA in the northern Gulf of Mexico.

2.6.3.3 Strike Group Training

Under this Alternative, Strike Group training exercises could be conducted in the designated ASW training areas within and adjacent to the VACAPES, CHPT, JAX/CHASN, or GOMEX OPAREAs. However, the majority of Strike Group training would continue to occur in the designated ASW areas within and seaward of the CHPT and JAX/CHASN OPAREAs.

2.6.3.3.1 Composite Unit Training Exercise

Under this Alternative, COMPTUEXs could be conducted in the designated ASW training areas within and adjacent to the VACAPES, CHPT, JAX/CHASN, or GOMEX OPAREAs. During these exercises, some activities may occur in more than one OPAREA.

2.6.3.3.2 Joint Task Force Exercise

JTFEX would occur in the designated ASW training areas within and adjacent to the JAX/CHASN or GOMEX OPAREA.

2.6.3.4 Maintenance Activities

2.6.3.4.1 Surface Ship Sonar Maintenance

Naval surface ships would operate their active sonar systems for maintenance while pier side at their homeport, located in either Norfolk, Virginia or Mayport, Florida. Additionally, maintenance could occur in any of the designated ASW training areas.

2.6.3.4.2 Submarine Sonar Maintenance

Submarines would conduct maintenance activities pier side at their homeport, located in either Groton, Connecticut; Norfolk, Virginia; or Kings Bay, Georgia. Additionally, sonar maintenance could occur in any of the designated active sonar areas as the system's performance may warrant.

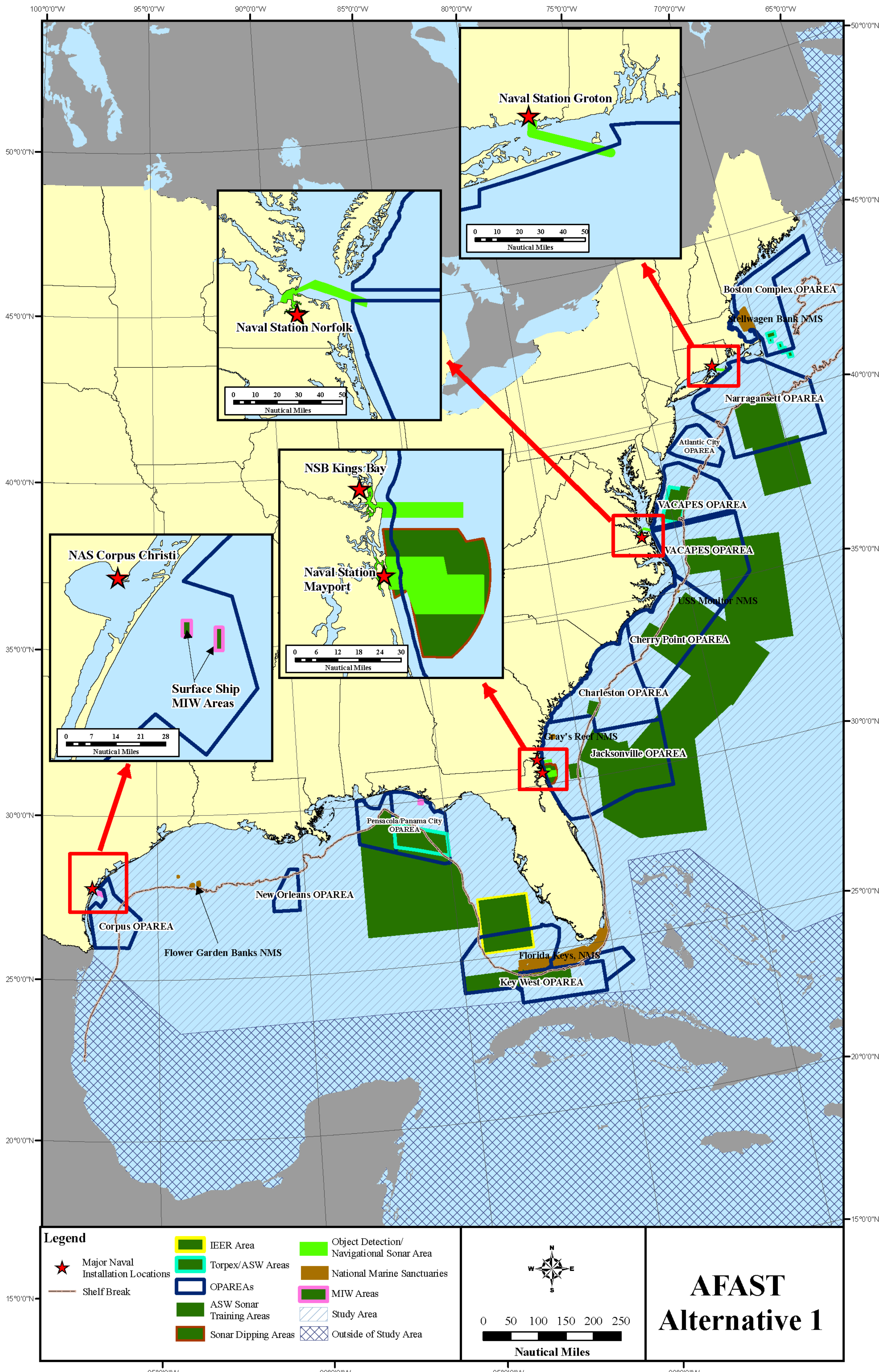


Figure 2-10. AFAST Alternative 1 – Active Sonar Activities would occur in Designated Areas (Overall)

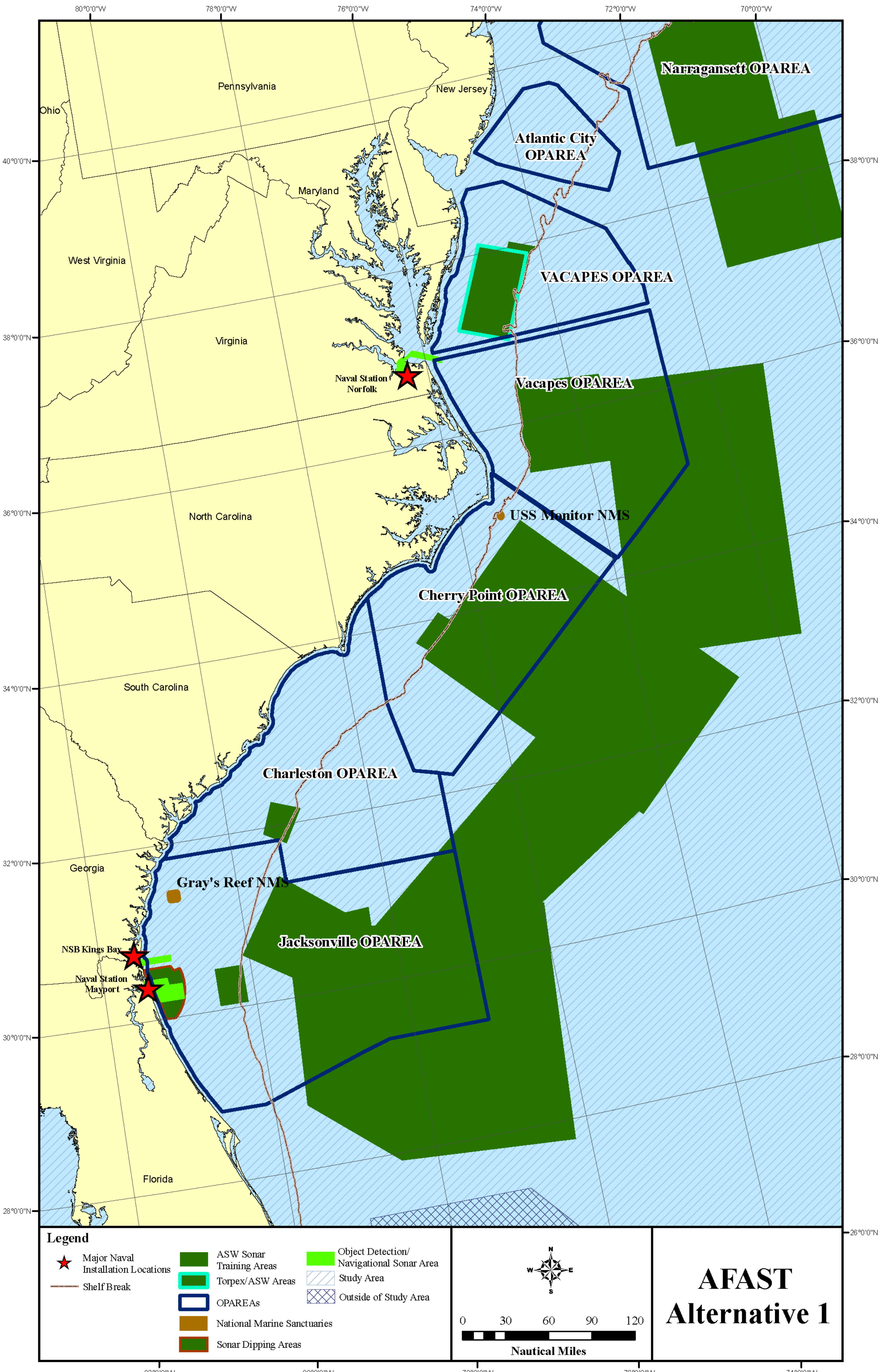


Figure 2-11. AFAST Alternative 1 – Active Sonar Activities would occur in Designated Areas (Southeast)

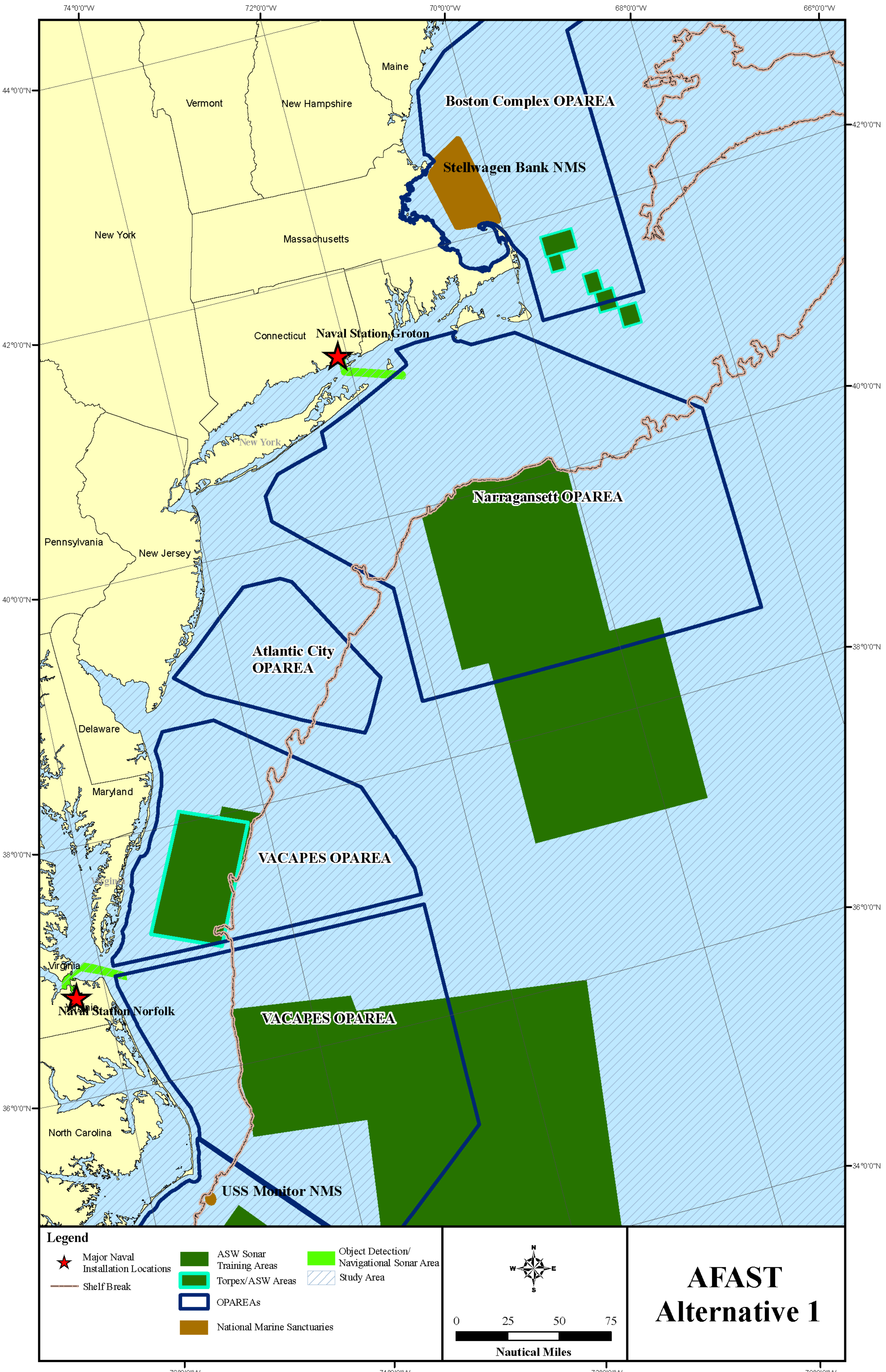


Figure 2-12. AFAST Alternative 1 – Active Sonar Activities would occur in Designated Areas (Northeast)

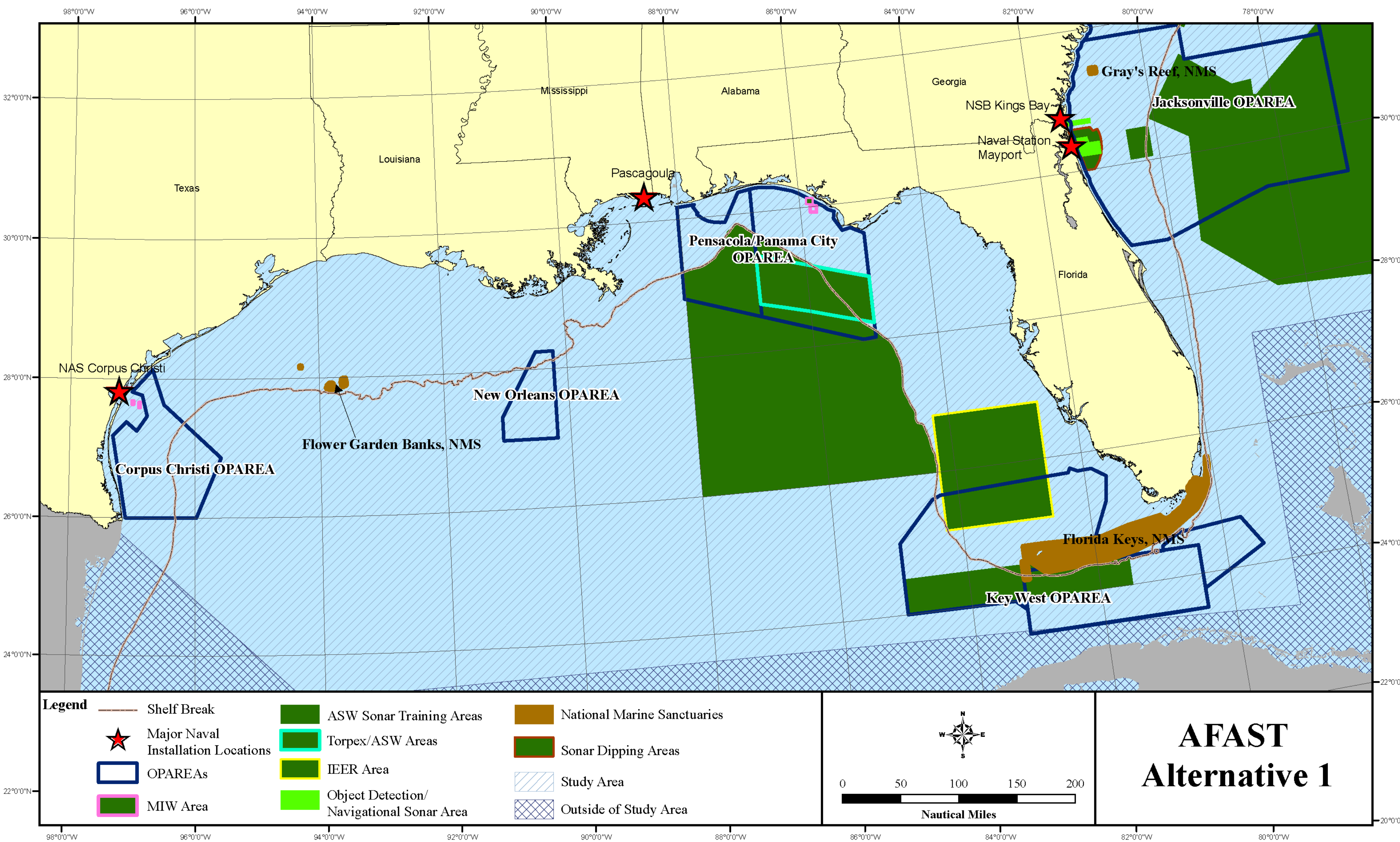


Figure 2-13. AFAST Alternative 1 – Active Sonar Activities would occur in Designated Areas (GOMEX)

2.6.4 Alternative 2 – Designate Seasonal Active Sonar Areas

Alternative 2 is to designate seasonal active sonar training areas based on operational criteria and quantitative and geographic environmental analysis. Training fidelity would be maximized by identifying locations based on replication of threat environments, proximity for multiple assets, safety of personnel, adequacy of training spaces, and availability of multiple training locations on a seasonal basis to support FRTP and surge. Alternative 1 uses fixed active sonar areas which are based on operational requirements. Environmental analyses were utilized as a starting point for the development of the Alternative 2 seasonal mid-frequency active sonar training areas.

Utilizing the approach discussed in Section 2.6.2, maps were generated for each season (spring, summer, fall, and winter) showing the projected exposures for seven marine species. Table 2-4 depicts the seasonal breakout used to define the seasons by specific calendar date beginning each season and ending each season.

Table 2-4. Seasonal Break-out by Calendar Date

Species	Season	Begin Season	End Season
East Coast of the U.S.			
General	Fall	1-Sep	30-Nov
General	Spring	1-Mar	31-May
General	Summer	1-Jun	31-Aug
General	Winter	1-Dec	28-Feb
Gulf of Mexico			
General	Fall	30-Sep	22-Dec
General	Spring	3-Apr	1-Jul
General	Summer	2-Jul	29-Sep
General	Winter	23-Dec	2-Apr

The Navy used these maps for the purpose of identifying areas of higher marine mammal exposures within the Alternative 1 active sonar training areas. The seasonal exposure data was compared to the Alternative 1 active sonar training areas, resulting in the reduction in specific training areas during the spring and winter and the addition of available training areas during the fall and summer. The Alternative 2 training areas remained consistent with the Alternative 1 active sonar training areas during the spring season. The seasonal changes to active sonar training areas are depicted in Figures 2-14 through 2-25. There were no seasonal changes in the GOMEX OPAREA. The trans-Atlantic routes associated with Navy vessel movements in and out of port would not change or be altered based on the development of this alternative. Additionally, the U.S. Navy does not plan to conduct active sonar activities within the Stellwagen Bank, Monitor, Gray's Reef, Flower Garden Banks, and Florida Keys National Marine Sanctuaries under the Alternative 2 and will avoid these sanctuaries by observing a 5 km (2.7 NM) buffer. In the event the Navy determines AFAST activities, due to operational requirements, are likely to destroy, cause the loss of, or injure any sanctuary resource (for Stellwagen Bank National Marine Sanctuary, the threshold is "may" destroy, cause the loss of, or injure), the Navy would first consult with the Director, Office of National Marine Sanctuaries in accordance with 16 U.S.C. 1434(d).

Based on habitat preferences and species behavioral patterns, densities of beaked whales, North Atlantic right whales, and sperm whales were used in the environmental analysis. However, due to the well-published sensitivities that beaked whales exhibit to mid-frequency active sonar, their seasonal densities served as the primary data to seasonally adjust the active sonar training area locations.

2.6.4.1 Independent ULT

2.6.4.1.1 Surface Ship ASW ULT

Similar to Alternative 1, surface ships would have the opportunity to conduct ASW training within any of the designated ASW training areas within and seaward of the Northeast, VACAPES, JAX/CHASN, CHPT, or GOMEX OPAREAs. Typically, training areas located near the homeports of Norfolk, Virginia, and Mayport, Florida, would be used. Seasonally, these areas have little variance. However, the VACAPES OPAREA becomes slightly smaller in the winter, while the JAX/CHASN OPAREA expands in summer and fall.

2.6.4.1.2 Surface Ship Object Detection/Navigational Sonar ULT

Similar to Alternative 1, the Navy would conduct this training primarily in the shallow water shipping lanes off the coasts of Norfolk, Virginia and Mayport, Florida. The transit lane servicing Mayport, Florida, crosses through the southeast North Atlantic right whale critical habitat.

2.6.4.1.3 Helicopter ASW ULT

The area used for ASW helicopter dipping training in the Alternative 1 would be the designated ASW helicopter dipping training area for Alternative 2 for use by shore based ASW helicopters out of Jacksonville, Florida. This area is located within the southeast North Atlantic right whale critical habitat. ASW helicopters embarked on surface ships would use designated ASW training areas.

2.6.4.1.4 Submarine ASW ULT

Navy submarines would have the opportunity to conduct shallow and deep water ASW training within any of the designated ASW training areas within and seaward of existing East Coast OPAREAs and within the GOMEX OPAREA. Seasonally, these areas have little variance. However, the designated training area within the VACAPES OPAREA becomes slightly smaller in the winter, while the area within the JAX/CHASN OPAREA expands in summer and fall.

2.6.4.1.5 Submarine Object Detection/Navigational Sonar ULT

Submarines would use sonar for object detection and navigation while entering and leaving their homeports, typically in shallow water transit lanes outside of Groton, Connecticut; Norfolk, Virginia; and Kings Bay, Georgia. As such, these locations would be the same as the No Action Alternative and Alternative 1. The transit lane servicing Kings Bay, Georgia, crosses through the southeast North Atlantic right whale critical habitat.

2.6.4.1.6 Maritime Patrol Aircraft ULT

Similar to Alternative 1, MPA ULT activities would be able to conduct ASW training using sonobuoys (tonal, passive, and explosive source) in any of the designated ASW training areas within and seaward of existing East Coast OPAREAs and occasionally in the designated ASW training areas within the GOMEX OPAREA. For explosive source sonobuoys (AN/SSQ-110A), an additional training range in the eastern GOMEX OPAREA would be established. Seasonally, these areas have little variance. However, the designated training area within the VACAPES OPAREA becomes slightly smaller in the winter, while the area within the JAX/CHASN OPAREA expands in summer and fall.

2.6.4.1.7 Surface Ship MIW ULT

Similar to the Alternative 1, this training would be conducted in the designated area within the GOMEX OPAREA in the northern Gulf of Mexico, and in the designated MIW areas within the Corpus Christi OPAREA off the east coast of Texas. There are no seasonal differences in the Gulf of Mexico.

2.6.4.2 Coordinated ULT

2.6.4.2.1 SEASWITI

Similar to Alternative 1, SEASWITI exercises would be conducted in one or more of the established ASW training areas within and seaward of the JAX/CHASN and CHPT OPAREAs. To meet the operational requirements for the maximum distance from homeport, the western boundary (i.e., training area entry point) of the SEASWITI training area must be between 167 and 185 km (90 and 100 NM) from port. Seasonally, the training area designated within the JAX/CHASN OPAREA becomes larger in the summer and fall.

2.6.4.2.2 Torpedo Exercise

As with Alternative 1, torpedo firing exercise would be conducted in one of the established ASW training areas within the VACAPES or GOMEX OPAREAs, or in the designated TORPEX boxes within and adjacent to the Northeast OPAREA. All torpedoes fired during these training activities are inert and are recovered. Since recovery operations are required, the training areas must within an acceptable distance (i.e., less than 148 km [80 NM]) of a support facility equipped to assist in the recovery of fired exercise torpedoes. There are no seasonal differences for these areas. The designated TORPEX boxes within and adjacent to the Northeast OPAREAs are located within North Atlantic right whale critical habitat and were established under previous ESA Section 7 consultations with NMFS. (Refer to Section 1.7.7 for additional information on previous consultations.)

2.6.4.2.3 Group Sail

The Group Sail exercises would be conducted in one or more of the established ASW training areas within and seaward of the VACAPES, JAX/CHASN, or CHPT OPAREAs. Seasonally, these areas have little variance. The ASW training area near the VACAPES OPAREA becomes slightly smaller in the winter, while the area in the northern part of the JAX/CHASN OPAREA expands in summer and fall.

2.6.4.2.4 Integrated ASW Course

IAC events typically take place within and seaward of the VACAPES, CHPT, and JAX/CHASN OPAREAs.

2.6.4.2.5 Submarine Commander's Course Operations

Similar to Alternative 1, SCC Operations would be conducted in the designated ASW training areas within and seaward of the JAX/CHASN and Northeast OPAREAs. Support vessels may be required for this training activity, since it is conducted in deep ocean areas and targets may be employed. As such, the western edge of the exercise boundary must be within 148 km (80 NM) of a support facility. Seasonally, the JAX/CHASN OPAREA training area expands slightly in the summer and fall.

2.6.4.2.6 Squadron Exercise and Gulf of Mexico Exercise

As with Alternative 1, the RONEX and GOMEX Exercise would be conducted in the ASW training area within and seaward of the GOMEX OPAREA in the northern Gulf of Mexico. There are no seasonal differences in the Gulf of Mexico.

2.6.4.3 Strike Group ULT

2.6.4.3.1 Composite Unit Training Exercise

As with Alternative 1, COMPTUEX activities under this alternative, would be conducted within and seaward of the designated ASW training areas in the VACAPES, CHPT, JAX/CHASN, and GOMEX OPAREAs. Seasonally, these areas have little variance. The VACAPES OPAREA training area becomes slightly smaller in the winter, while the JAX/CHASN OPAREA training area expands in summer and fall.

2.6.4.3.2 Joint Task Force Exercise

JTFEX would occur in the designated ASW training areas within and seaward of the JAX/CHASN or GOMEX OPAREA. Seasonally, the JAX/CHASN OPAREA training area expands in summer and fall.

2.6.4.4 Maintenance Activities

Maintenance activities could occur in homeports located in territorial waters, or in the open ocean within non-territorial waters.

2.6.4.4.1 Surface Ship Sonar Maintenance

As with the Alternative 1, naval surface ships would operate their active sonar systems for maintenance while pier side within their homeport, located in either Norfolk, Virginia or

Mayport, Florida. Additionally, open ocean sonar maintenance could occur anywhere within the non-territorial waters of the AFAST Study Area as the system's performance may warrant.

2.6.4.4.2 Submarine Sonar Maintenance

As with the Alternative 1, submarines would conduct maintenance to their sonar systems pier side in their homeports of either Groton, Connecticut; Norfolk, Virginia; or Kings Bay, Georgia. Additionally, sonar maintenance could occur anywhere within the non-territorial waters of the AFAST Study Area as the system's performance may warrant.

This page is intentionally blank.

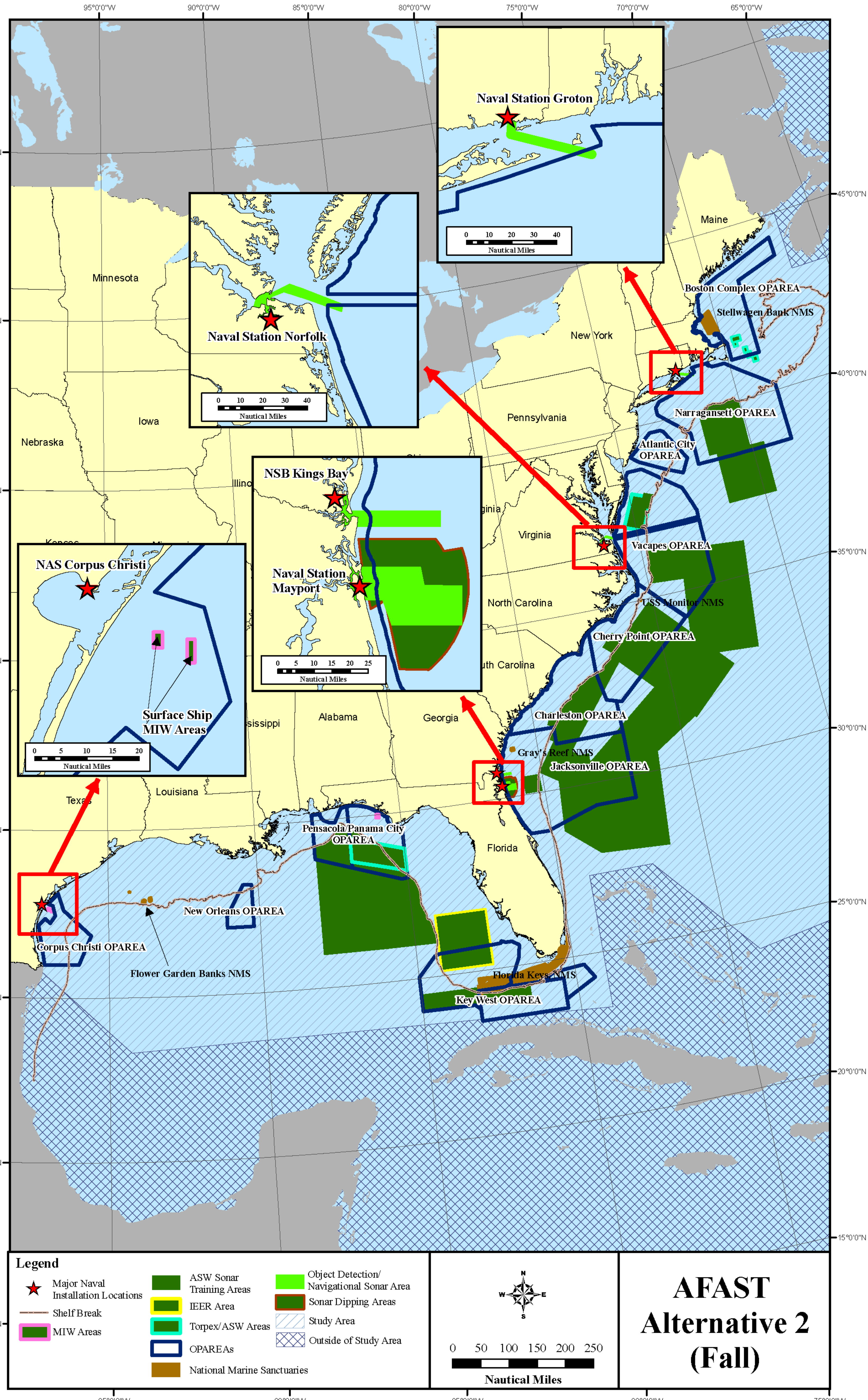


Figure 2-14. AFAST Alternative 2 – Active Sonar Activities would occur in Designated Areas (Overall—Fall Season)

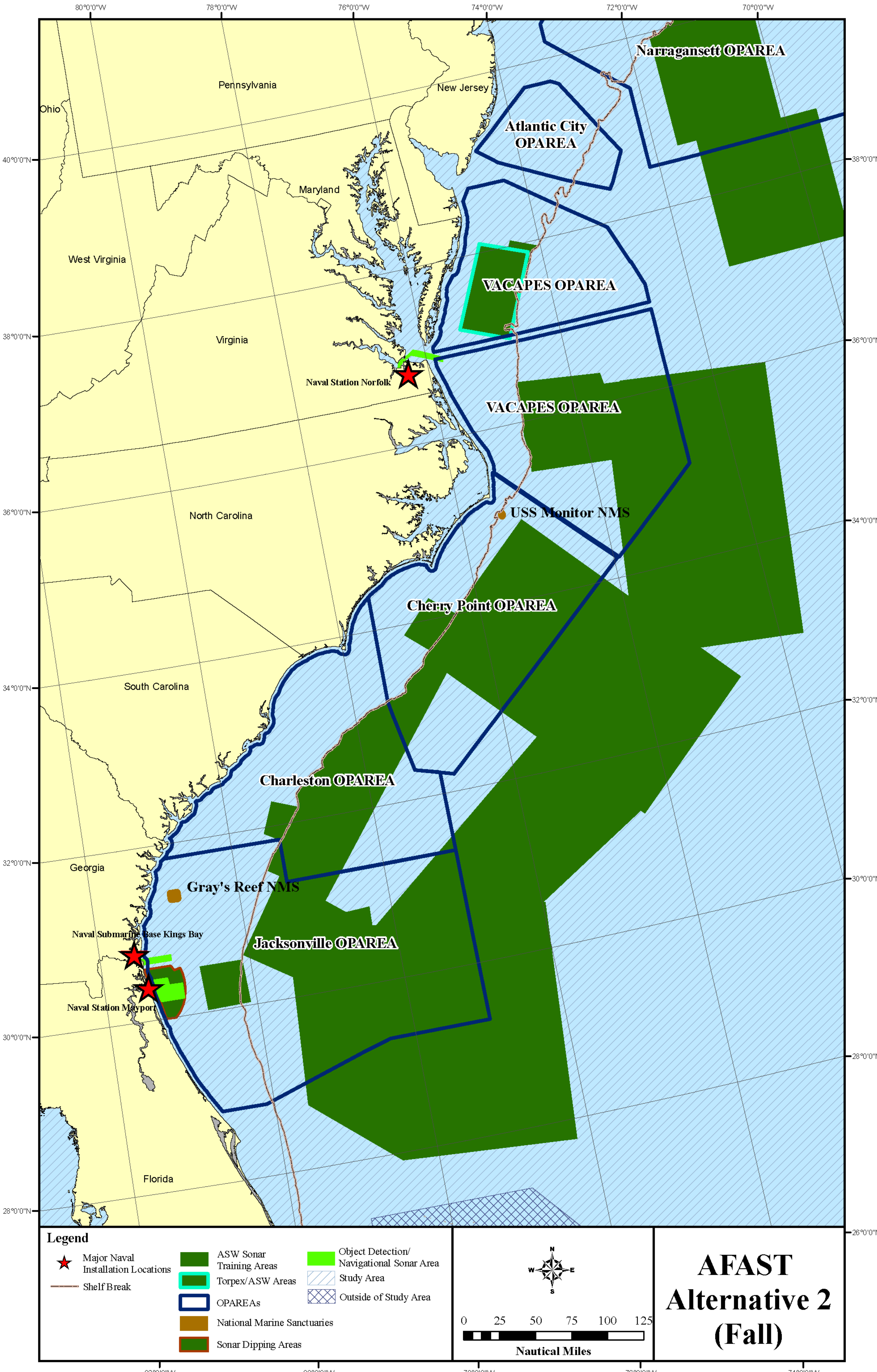


Figure 2-15. AFAST Alternative 2 – Active Sonar Activities would occur in Designated Areas (Southeast—Fall Season)

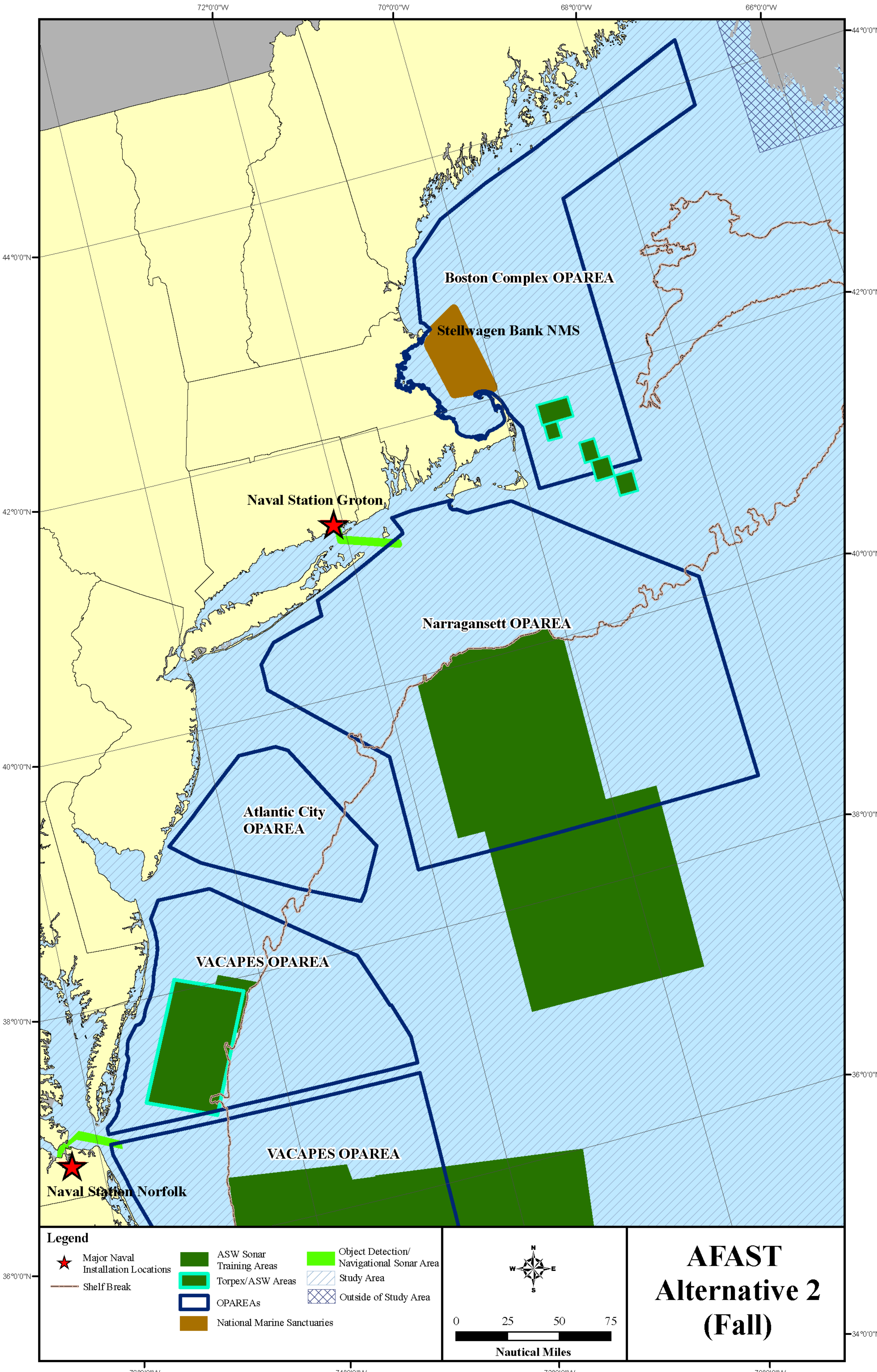


Figure 2-16. AFAST Alternative 2 – Active Sonar Activities would occur in Designated Areas (Northeast—Fall Season)

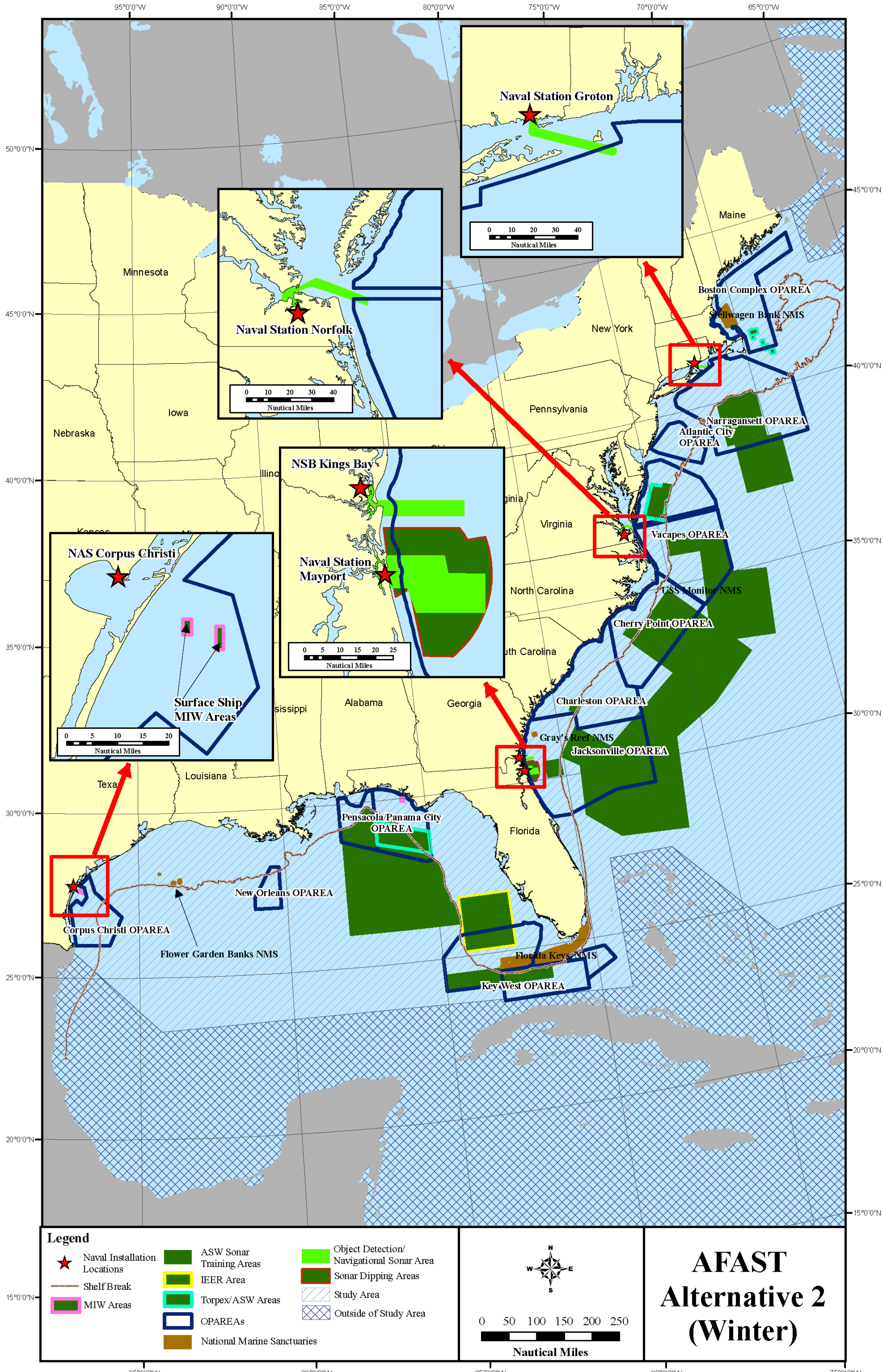


Figure 2-17. AFAST Alternative 2 – Active Sonar Activities would occur in Designated Areas (Overall—Winter Season)

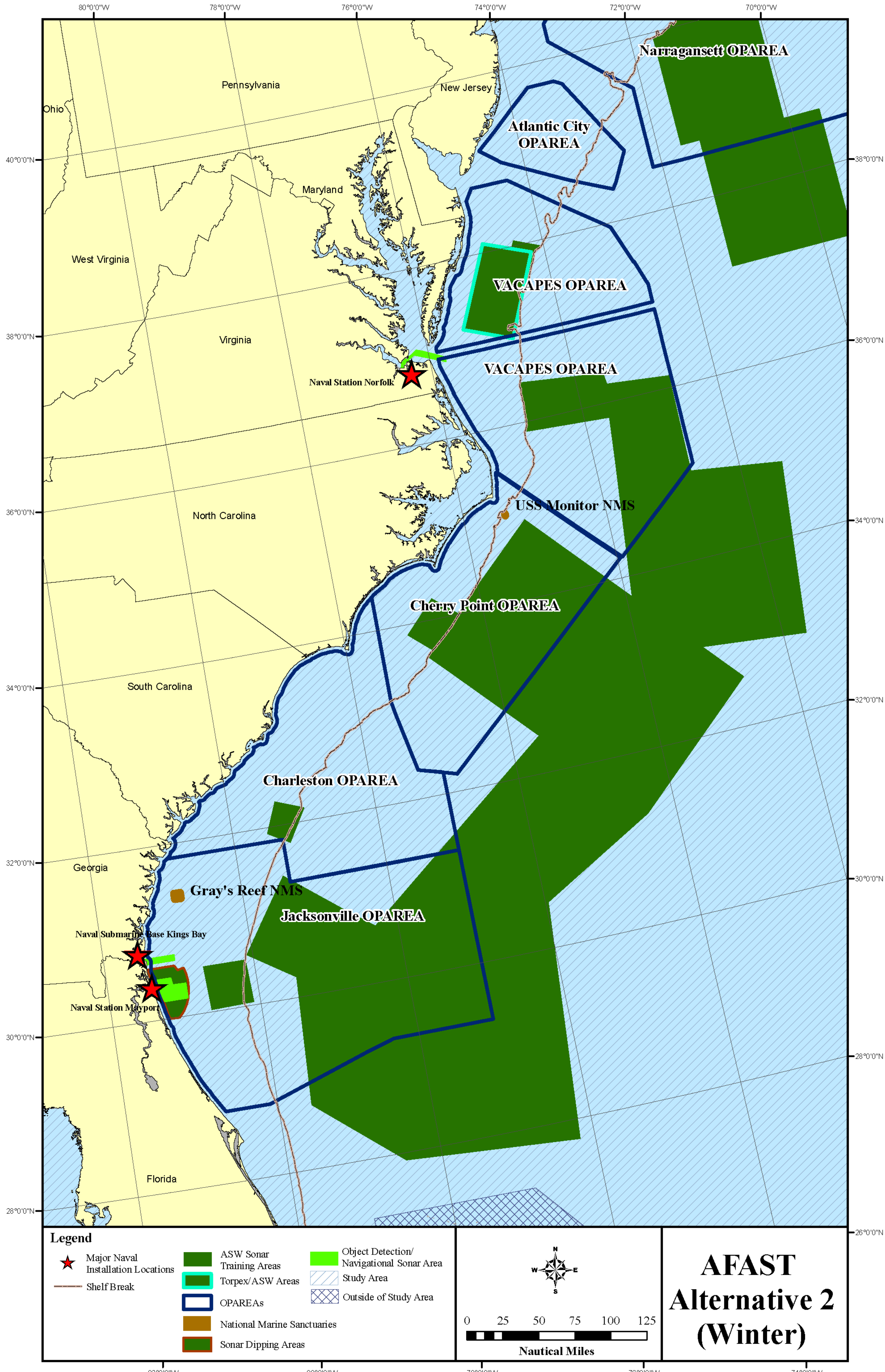


Figure 2-18. AFAST Alternative 2 – Active Sonar Activities would occur in Designated Areas (Southeast—Winter Season)

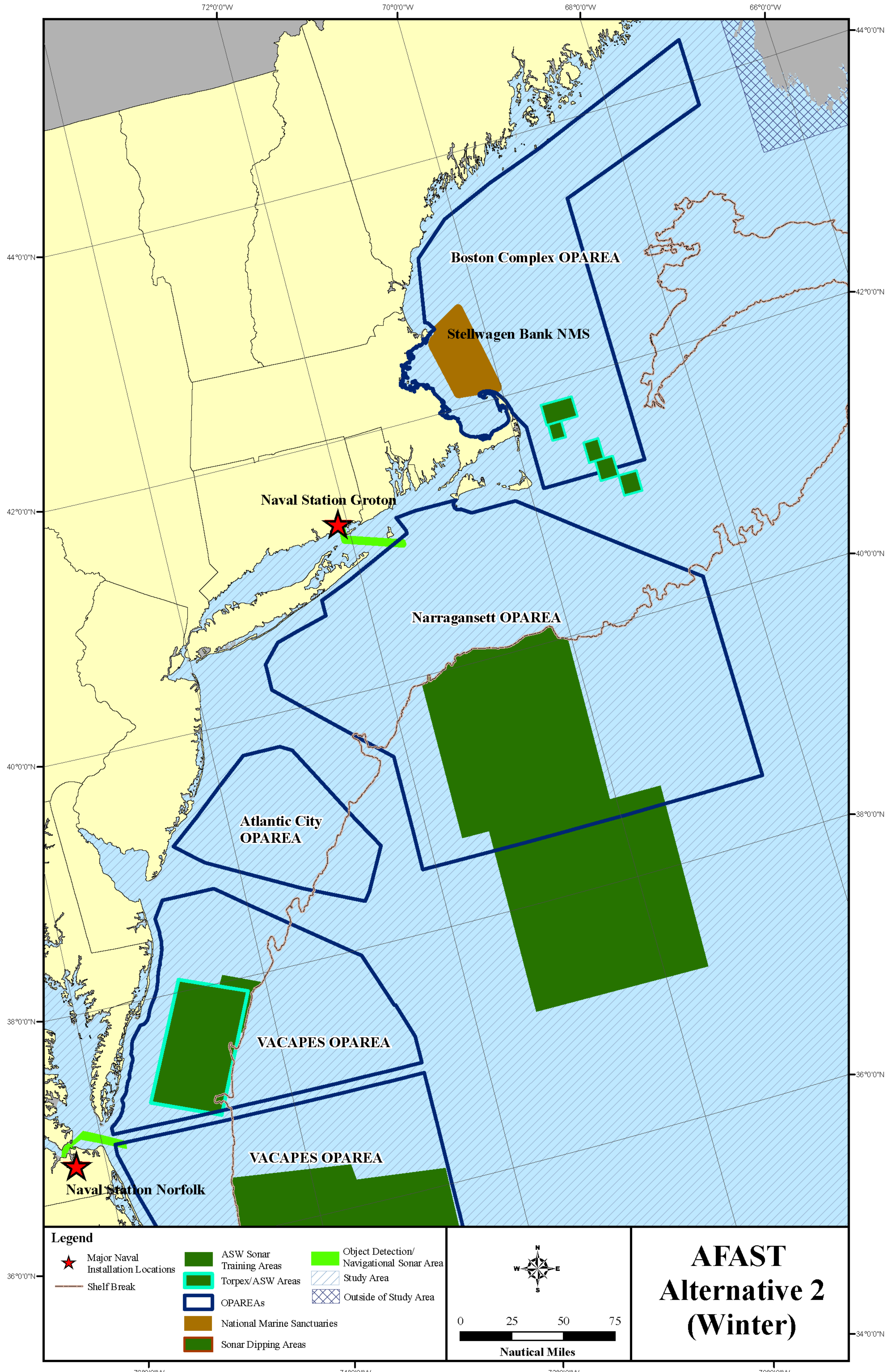


Figure 2-19. AFAST Alternative 2 – Active Sonar Activities would occur in Designated Areas (Northeast—Winter Season)

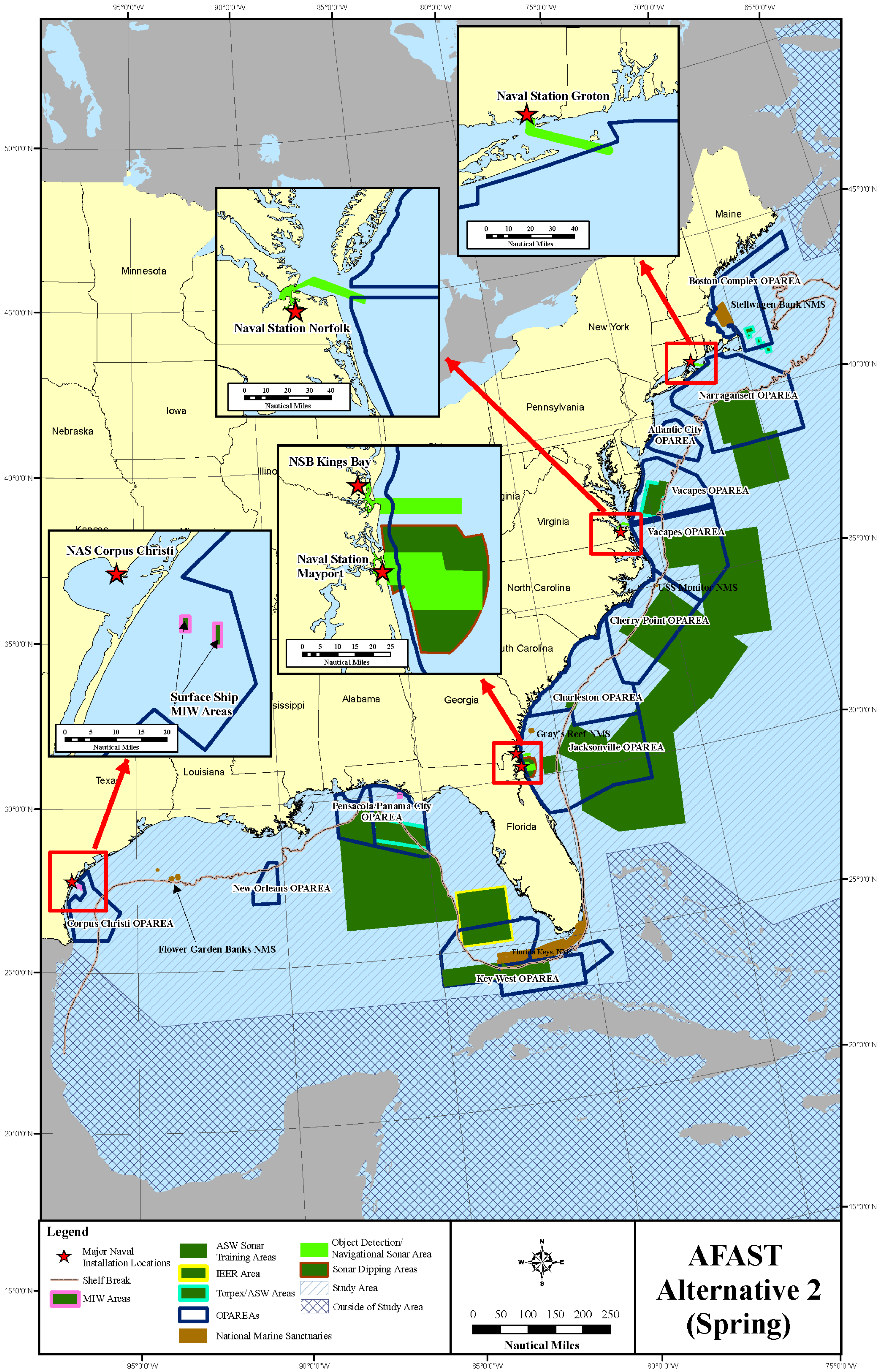


Figure 2-20. AFAST Alternative 2 – Active Sonar Activities would occur in Designated Areas (Overall—Spring Season)

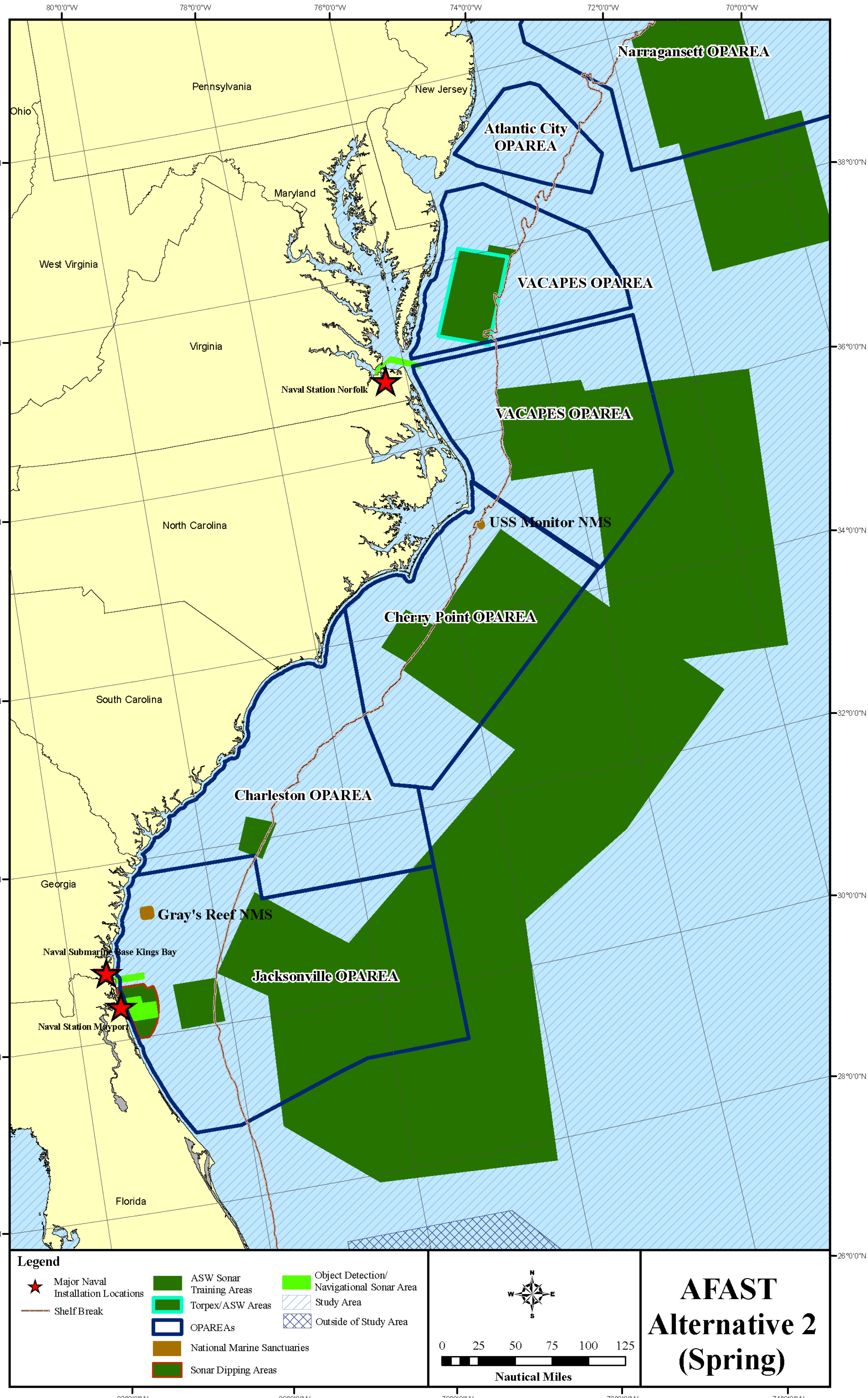


Figure 2-21. AFAST Alternative 2 – Active Sonar Activities would occur in Designated Areas (Southeast—Spring Season)

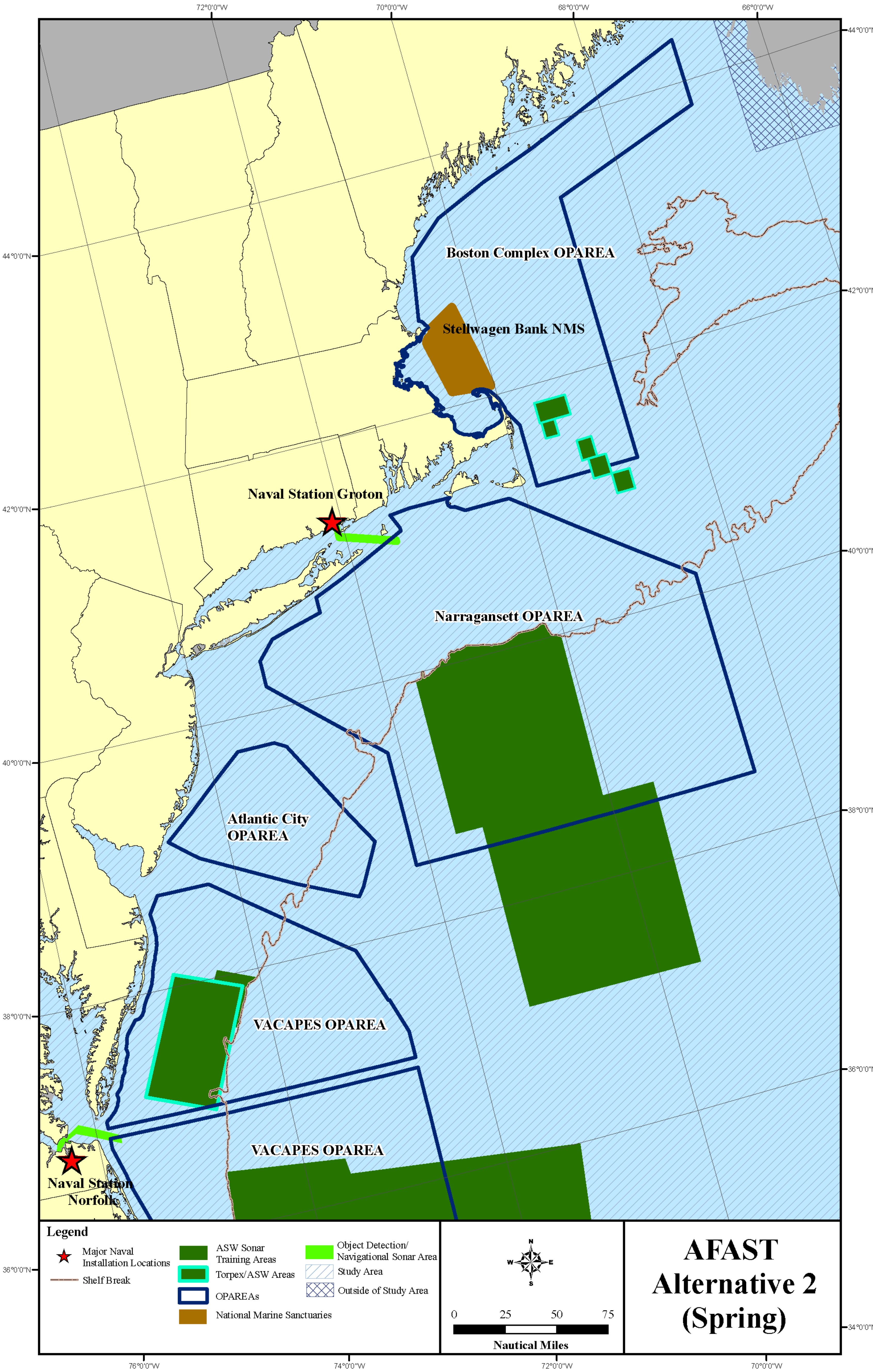


Figure 2-22. AFAST Alternative 2 – Active Sonar Activities would occur in Designated Areas (Northeast—Spring Season)

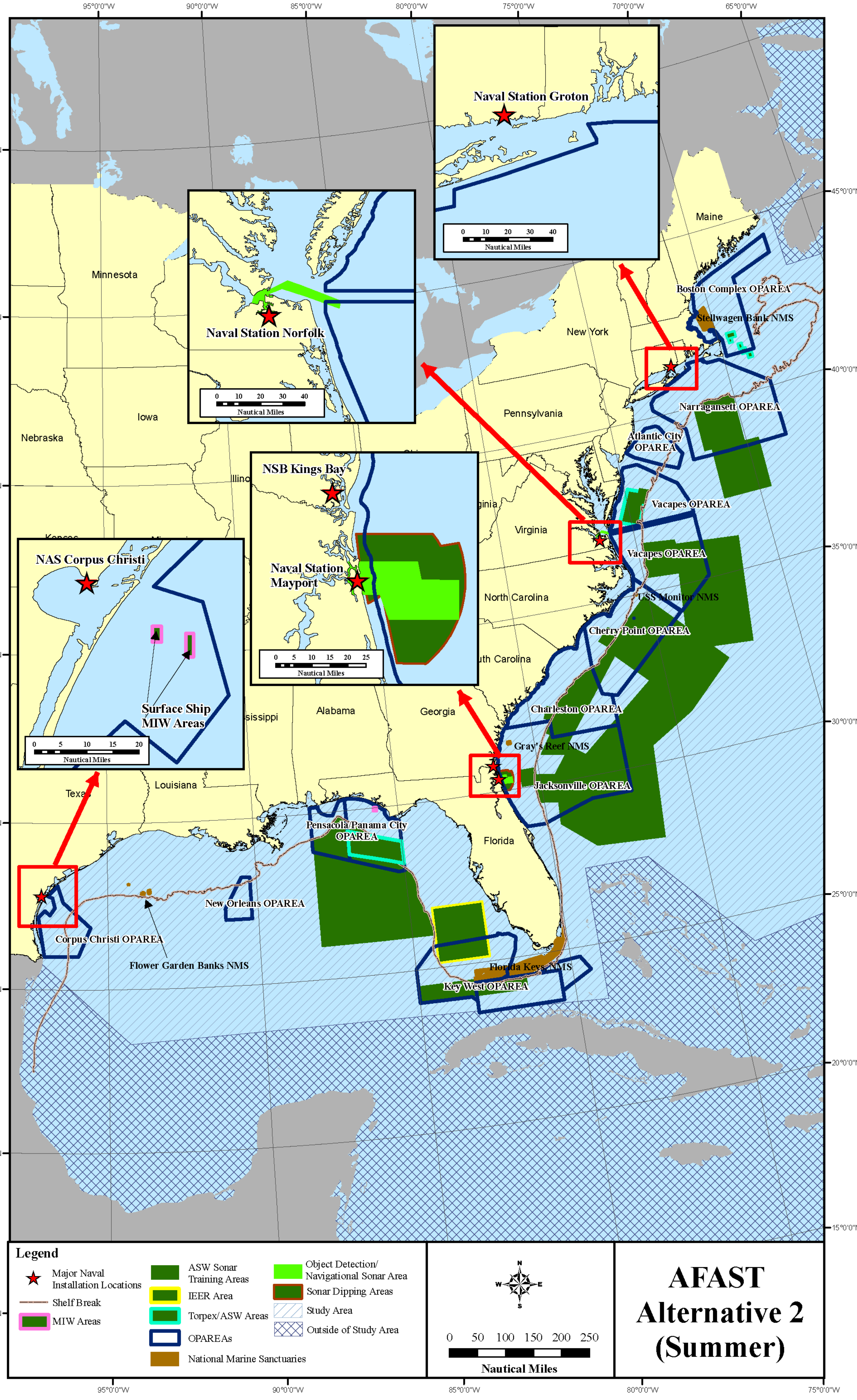


Figure 2-23. AFAST Alternative 2 – Active Sonar Activities would occur in Designated Areas (Overall—Summer Season)

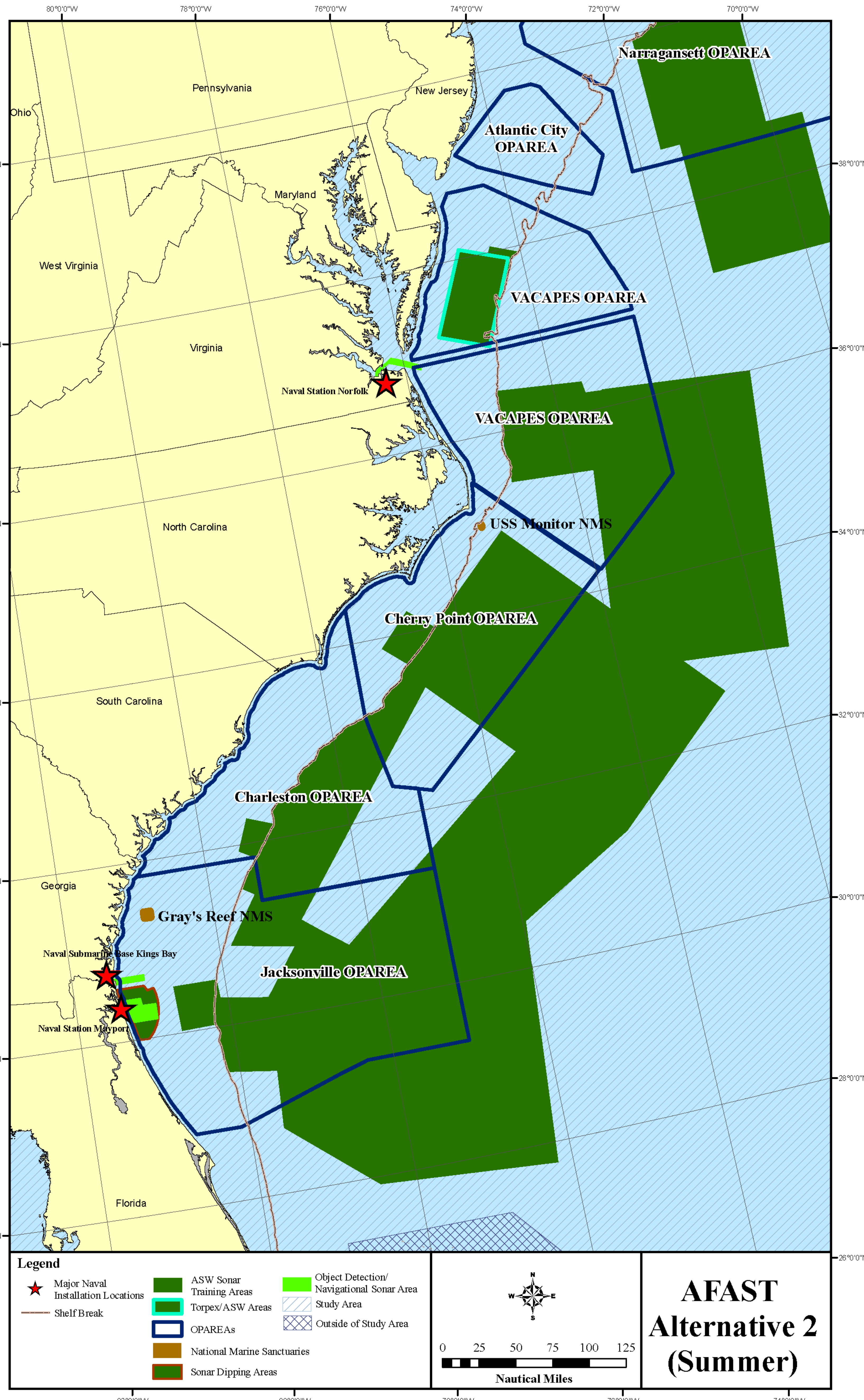


Figure 2-24. AFAST Alternative 2 – Active Sonar Activities would occur in Designated Areas (Southeast—Summer Season)

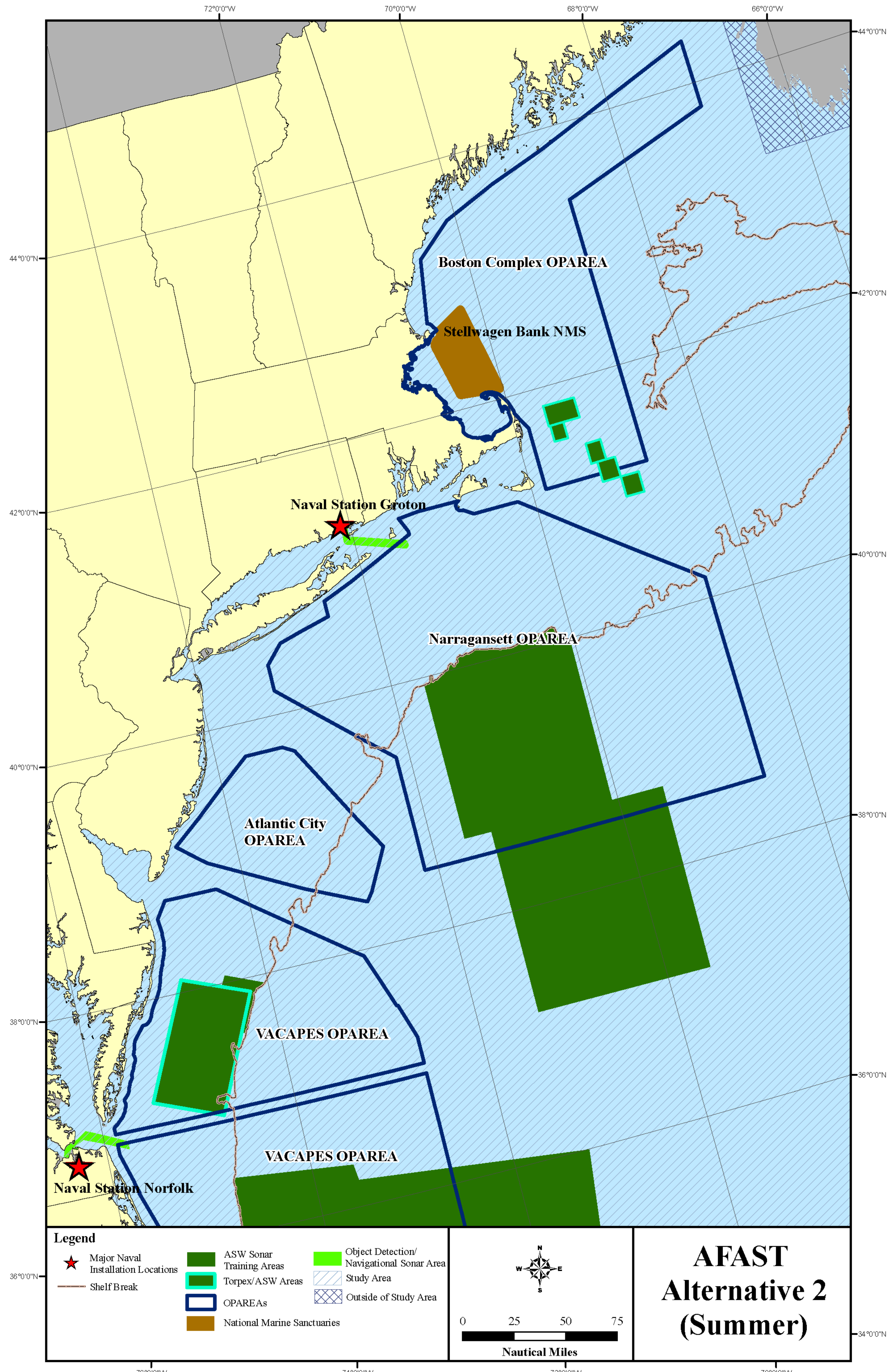


Figure 2-25. AFAST Alternative 2 – Active Sonar Activities would occur in Designated Areas (Northeast—Summer Season)

2.6.5 Alternative 3 – Designated Areas of Increased Awareness

In addition to considering the surrogate marine mammal acoustic exposure analysis to develop a reasonable range of alternatives, a number of other habitat types were considered and included in the development of Alternative 3. Under Alternative 3, active sonar activities would not be conducted in designated areas of increased awareness located offshore of the U.S. East Coast and within the Gulf of Mexico to the extent allowable while meeting operational requirements. However, the trans-Atlantic routes associated with vessel movements in and out of port would not change or be altered based on the development of this alternative. Designated areas of increased awareness are environmentally sensitive areas that typically indicate higher concentrations of marine species and include the following features:

- Bathymetric features such as canyons, steep walls, and seamounts
- Areas of persistent oceanographic features
- North Atlantic right whale critical habitat areas
- River and bay mouths
- Areas of high marine mammal density (refer to Appendix D for more information)
- Designated National Marine Sanctuaries (i.e., Monitor, Gray's Reef, Stellwagen Bank, Florida Keys, and Flower Garden Banks)

It is important to note that the U.S. Navy does not plan to conduct active sonar activities within the Stellwagen Bank, Monitor, Gray's Reef, Flower Garden Banks, and Florida Keys National Marine Sanctuaries under the Alternative 3 and will avoid these sanctuaries by observing a 5 km (2.7 NM) buffer. In the event the Navy determines AFAST activities, due to operational requirements, are likely to destroy, cause the loss of, or injure any sanctuary resource (for Stellwagen Bank National Marine Sanctuary, the threshold is "may" destroy, cause the loss of, or injure), the Navy would first consult with the Director, Office of National Marine Sanctuaries in accordance with 16 U.S.C. 1434(d).

All marine waters within the AFAST Study Area, but outside the designated areas of increased awareness identified in Figures 2-26 through 2-29, would be open to active sonar activities. Due to operational requirements, there are several types of active sonar activity areas that cross designated areas of increased awareness; however, these areas are limited and described below in the following sections.

2.6.5.1 Independent ULT Areas

Currently, Independent ASW ULT activities are distributed across the OPAREAs and seaward.

2.6.5.1.1 Surface Ship ASW

Similar to the No Action Alternative, Surface Ship ASW ULT would primarily be occurring within and adjacent to the East Coast OPAREAs, but not within designated areas of increased awareness.

2.6.5.1.2 Surface Ship Object Detection/Navigational Sonar ULT

As with the No Action Alternative, this training would be conducted primarily in the shallow water shipping lanes off the coasts of Norfolk, Virginia and Mayport, Florida. These shallow water shipping lanes do cross the designated areas of increased awareness but are typically only a few nautical miles wide. The transit lane servicing Mayport, Florida, crosses through the southeast North Atlantic right whale critical habitat.

2.6.5.1.3 Helicopter ASW ULT

Similar to the No Action Alternative, while ASW helicopter are embarked on surface ships they would train primarily within the East Coast OPAREAs with the exception of the designated areas of increased awareness. Shore-based ASW helicopters from Jacksonville, Florida, would utilize the established helicopter dipping area due to the proximity to the home base. This dipping area is within a designated area of increased awareness and is partially within the southeast North Atlantic right whale critical habitat.

2.6.5.1.4 Submarine ASW ULT

Similar to the No Action Alternatives, submarines would conduct this training in deep waters throughout the Study Area, within and seaward of existing East Coast OPAREAs and occasionally in the GOMEX OPAREA. However, active sonar training would not occur within designated areas of increased awareness.

2.6.5.1.5 Submarine Object Detection/Navigational Sonar ULT

Submarines use sonar for object detection and navigation while entering and leaving their homeports, typically in shallow water. Similar to the No Action Alternative, this type of ULT would occur in the established submarine transit lanes outside of Groton, Connecticut; Norfolk, Virginia; and Kings Bay, Georgia. All of the submarine transit lanes cross through the designated areas of increased awareness, and the transit lane servicing Kings Bay, Georgia, crosses through the southeast North Atlantic right whale critical habitat.

2.6.5.1.6 Maritime Patrol Aircraft ASW ULT

MPA would deploy active sonars for ASW training using sonobuoys (tonal, passive, and explosive source sonobuoys (AN/SSQ-110A) typically in deep water, and occasionally in shallow water. Similar to the No Action Alternative, MPA ASW ULT would occur within and seaward of existing East Coast OPAREAs and occasionally within the GOMEX OPAREA. Active sonar training would not occur within designated areas of increased awareness.

2.6.5.1.7 Surface Ship MIW ULT

Navy MIW ships would operate their active sonars for mine detection training primarily in shallow water OPAREAs in the Gulf of Mexico. Similar to the No Action Alternative, this training would be conducted in OPAREAs in the northern Gulf of Mexico in the GOMEX OPAREA, and off the east coast of Texas, in the Corpus Christi OPAREA. Designated MIW ranges are very small, on the order of a few square miles, but are within areas of increased awareness offshore Florida and Texas.

2.6.5.2 Coordinated ULT Areas

2.6.5.2.1 SEASWITI

Similar to the No Action Alternative, SEASWITI training exercises would occur in the deep-water OPAREAs off the coast of Jacksonville, Florida. To meet the operational requirements for the maximum distance from homeport, the western boundary (i.e., training area entry point) of the SEASWITI training area must be between 167 and 185 km (90 and 100 NM) from port.

2.6.5.2.2 Torpedo Exercise

ASW training involving torpedo firing would occur within the VACAPES and GOMEX OPAREAs outside of areas of increased awareness, however designated TORPEX boxes within and adjacent to the Northeast OPAREA would reside within areas of increased awareness that are based on North Atlantic right whale critical habitat. These training areas were established during previous ESA Section 7 consultations with NMFS. (Refer to Section 1.7.7 for additional information on previous consultations.)

2.6.5.2.3 Group Sail

Similar to the No Action Alternative, these events would take place within and seaward of the VACAPES, CHPT, and JAX/CHASN OPAREAs. Active sonar training would not occur within designated areas of increased awareness.

2.6.5.2.4 Integrated ASW Course

IAC events typically take place within and seaward of the VACAPES, CHPT, and JAX/CHASN OPAREAs.

2.6.5.2.5 Submarine Commander's Course Operations

Similar to the No Action Alternative, this training exercise would occur in the JAX/CHASN and Northeast OPAREAs. The training would be conducted in deep ocean areas, and due to the fact that MK-39 EMATTs or MK-30 targets may be employed as a target, a support vessel may be required. This limits the western edge of the exercise boundary to within 148 km (80 NM) of a support facility.

2.6.5.2.6 Squadron Exercise and Gulf of Mexico Exercise

As with the No Action Alternative, the RONEX and GOMEX Exercise would be conducted in both deep and shallow water training areas in the northern Gulf of Mexico in the GOMEX OPAREA. Active sonar training would not occur within designated areas of increased awareness.

2.6.5.3 Strike Group Training Areas

2.6.5.3.1 Composite Training Unit Exercise

Similar to the No Action Alternative, these exercises would be conducted within and seaward of the VACAPES, CHPT, and JAX/CHASN OPAREAs, or within the GOMEX OPAREA. Active sonar training would not occur within designated areas of increased awareness.

2.6.5.3.2 Joint Task Force Exercise

Similar to the No Action Alternative, JTFEX activities would occur in shallow and deep water portions located within and seaward of the JAX/CHASN OPAREA, and within the GOMEX OPAREA. Active sonar training would not occur within designated areas of increased awareness.

2.6.5.4 Sonar Maintenance Activities

2.6.5.4.1 Surface Ship Sonar Maintenance

As with the No Action Alternative, surface ships would operate their active sonar systems for maintenance while in shallow water near their homeport, located in either Norfolk, Virginia or Mayport, Florida. However, sonar maintenance could occur anywhere outside the areas of increased awareness as the system's performance may warrant.

2.6.5.4.2 Submarine Sonar Maintenance

Similar to the No Action Alternatives, submarines would conduct maintenance on their sonar systems in shallow water near their homeport of either Groton, Connecticut; Norfolk, Virginia; or Kings Bay, Georgia. However, sonar maintenance could occur anywhere outside the areas of increased awareness as the system's performance may warrant.

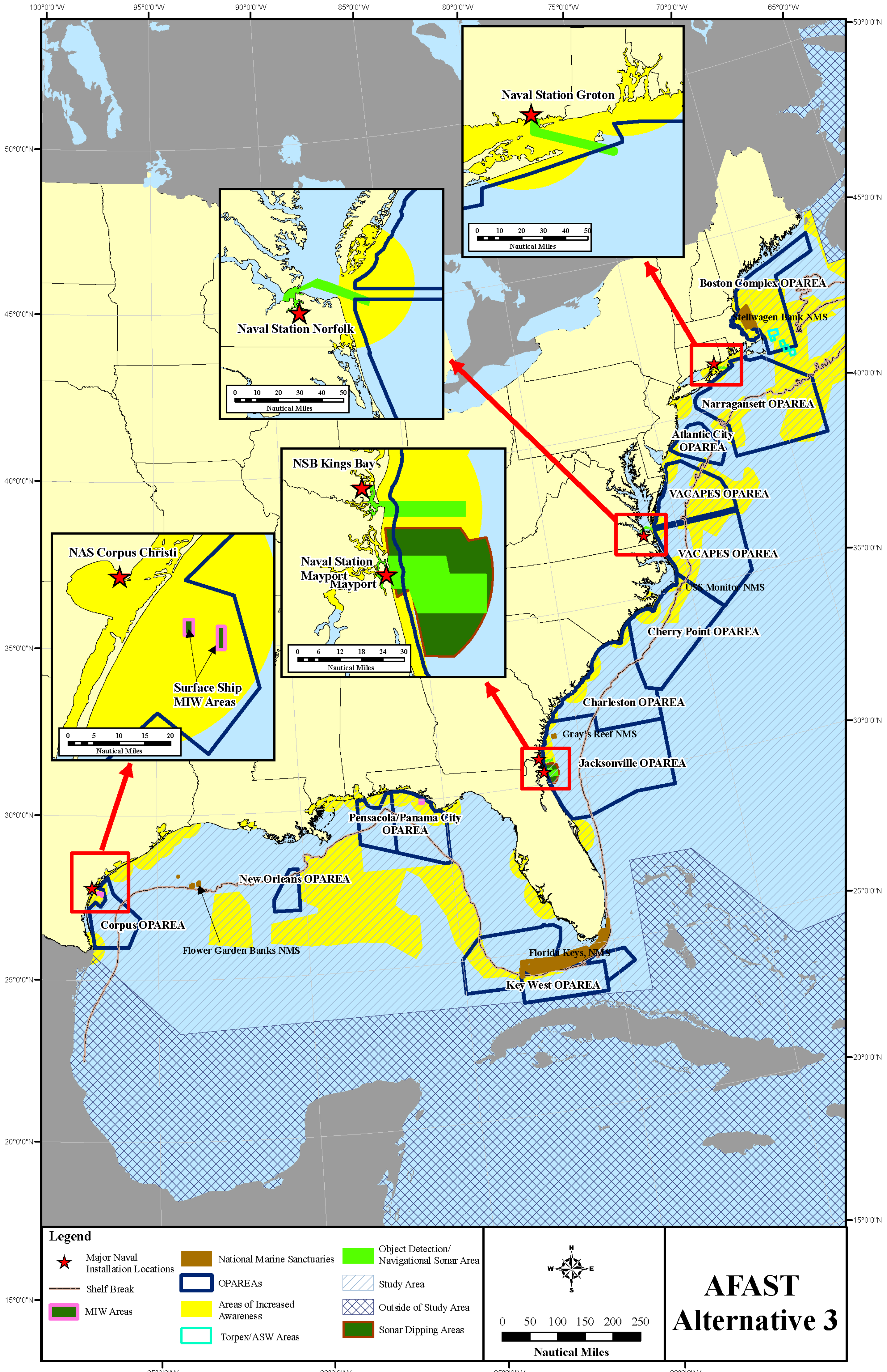


Figure 2-26. AFAST Alternative 3 – Active Sonar Activities would occur Outside of Areas of Increased Awareness (Overall)

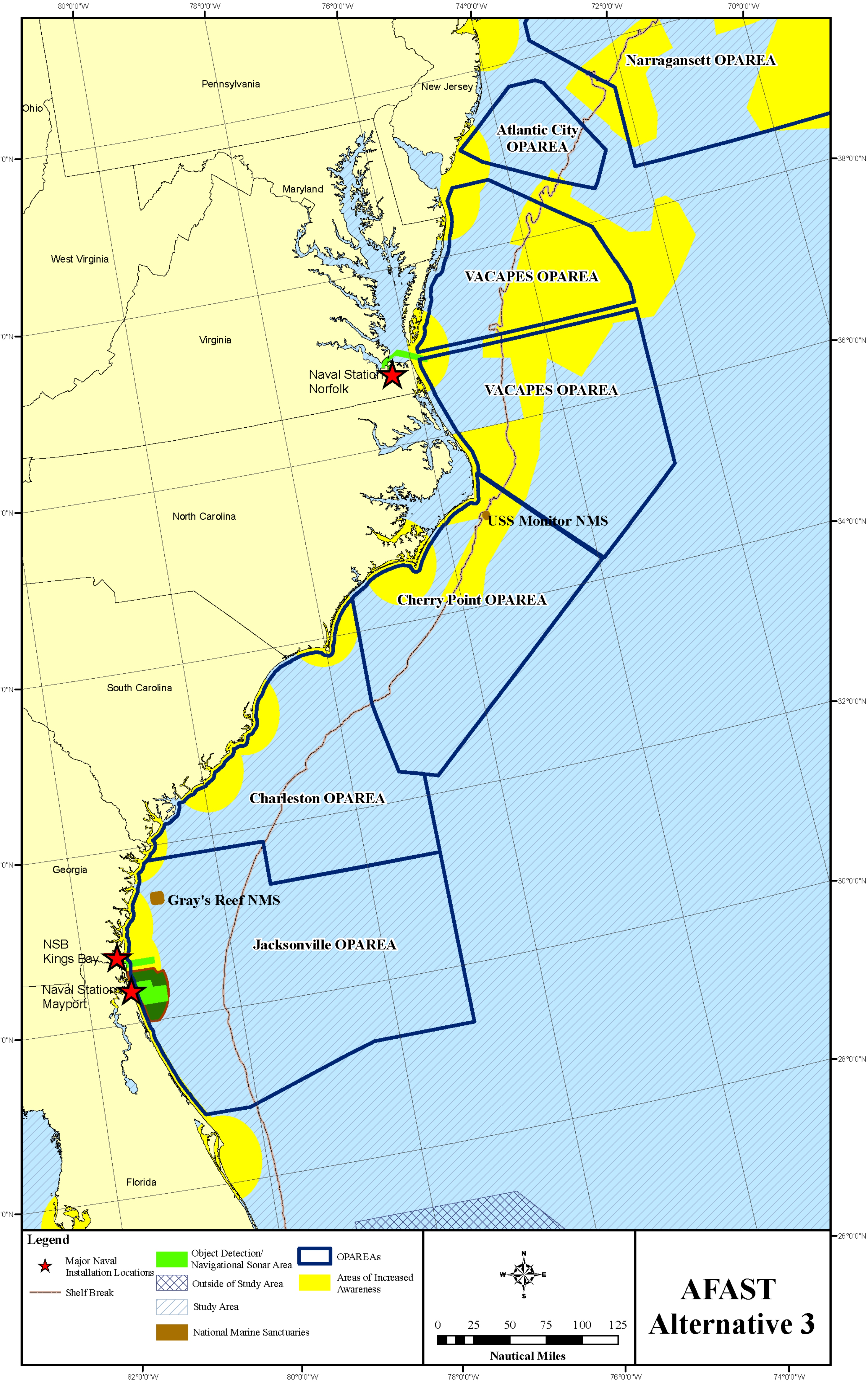


Figure 2-27. AFAST Alternative 3 – Active Sonar Activities would occur Outside of Areas of Increased Awareness (Southeast)

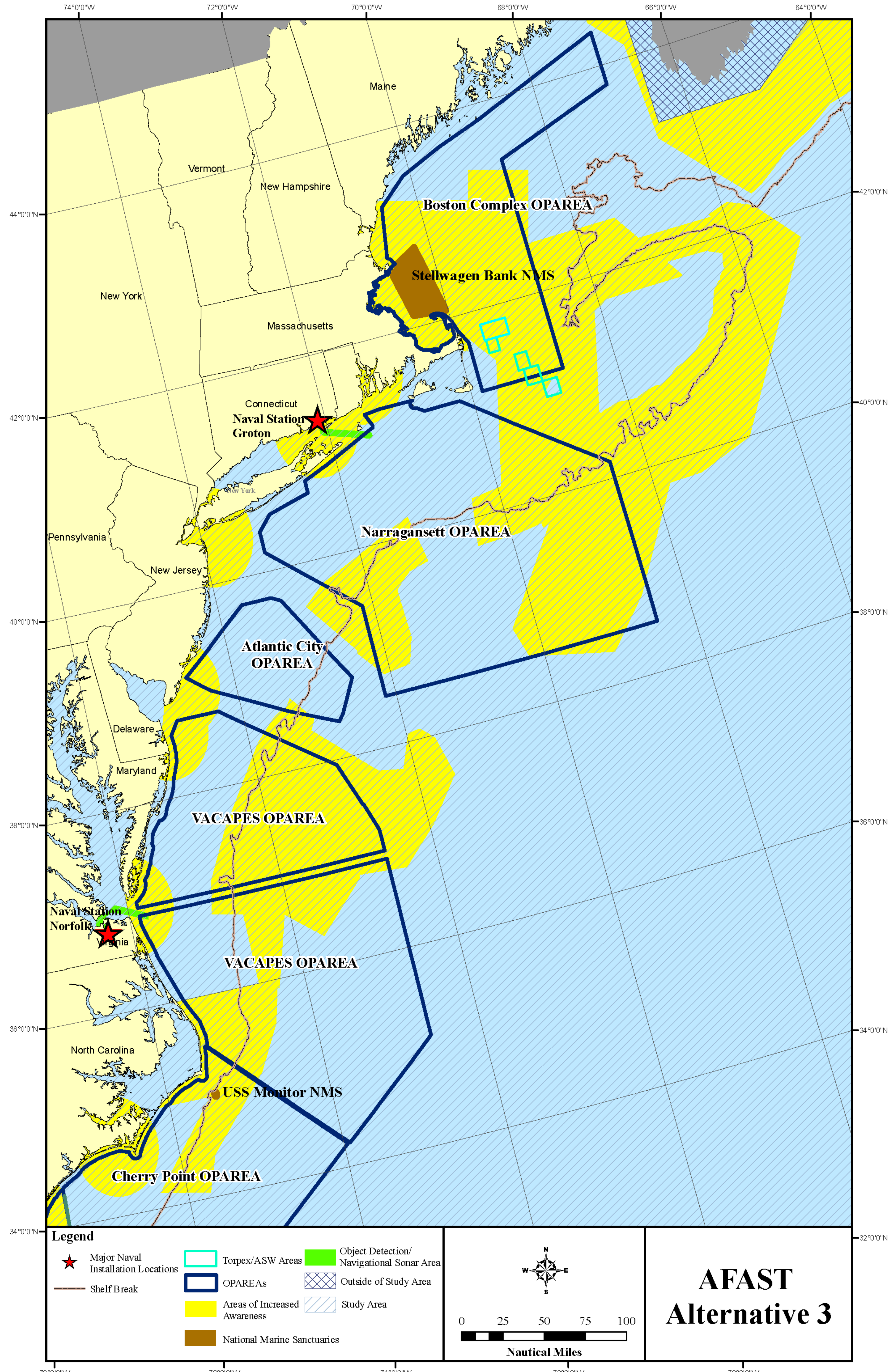


Figure 2-28. AFAST Alternative 3 – Active Sonar Activities would occur Outside of Areas of Increased Awareness (Northeast)

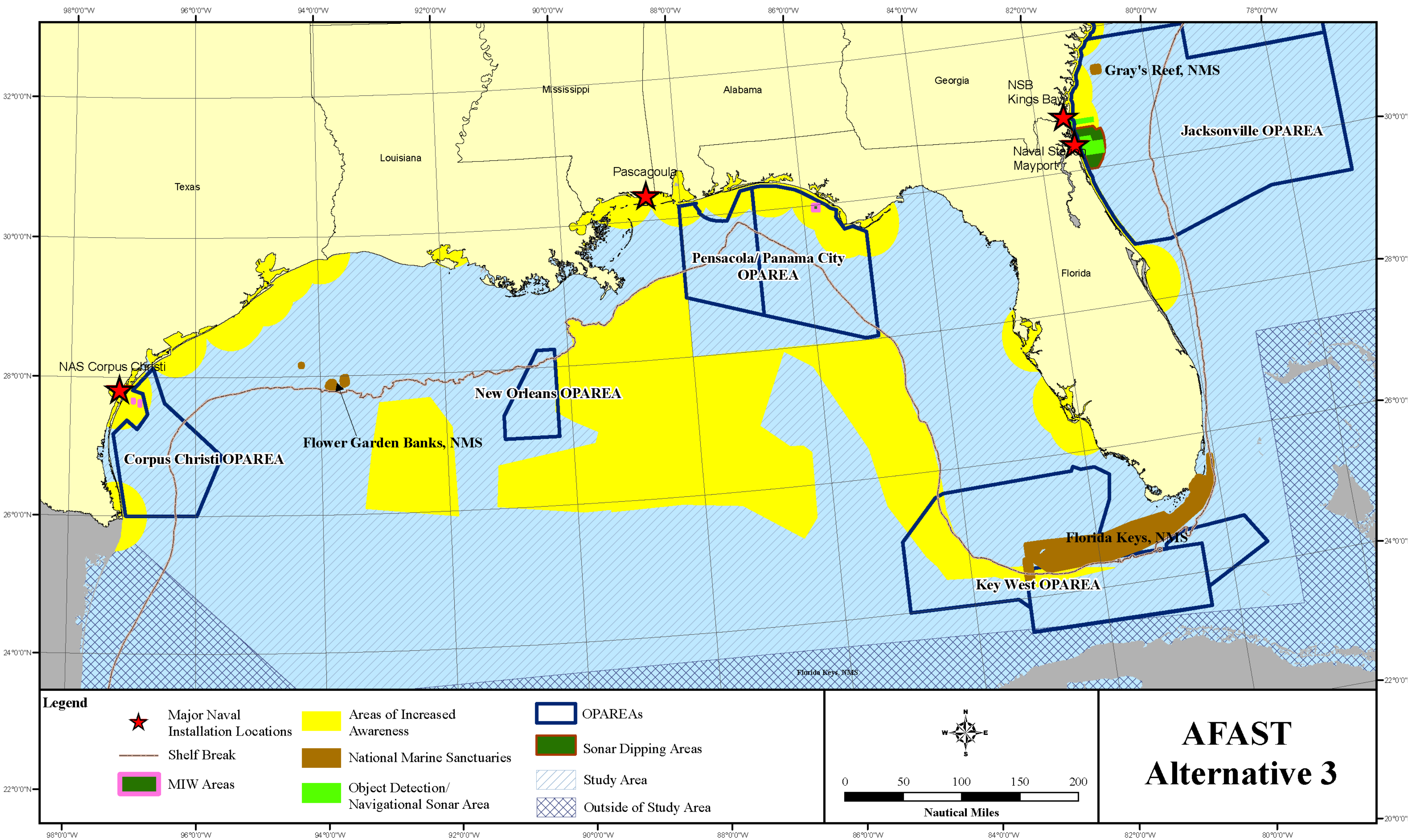


Figure 2-29. AFAST Alternative 3 – Active Sonar Activities would occur Outside of Areas of Increased Awareness (GOMEX)

2.6.5.5 Bathymetric Features (i.e., Canyons, Steep Walls, and Seamounts)

Canyon areas are very productive areas for marine life and provide deep-water habitat required to sustain deep diving marine mammals such as sperm and beaked whales. Based on the sensitivity of the marine mammals known to inhabit these deep-water areas, it was decided that the area of increased awareness for canyons should begin at the shelf break and extend seaward until the outer canyon wall reaches an approximate 2 percent slope. Thus, it was decided that increased awareness areas offshore the U.S. East Coast would extend from the shelf break seaward to the 1,500 m (4,921 ft) bathymetric curve. Areas of increased awareness in the Gulf of Mexico would extend from the shelf break seaward to the 1,600 m (5,249 ft) bathymetric curve. An additional 10 km (5 NM) buffer shoreward of the shelf break and 5 km (3 NM) buffer seaward of the outer canyon wall was added to the designated area of increased awareness. However, based on operational requirements, a section in the GOMEX OPAREA near DeSoto Canyon is required for Strike Group training. A maximum of one combined CSG COMPTUEX/ JTFEX could occur there, but not necessarily every year.

In addition, there is a deep-water trench not associated with a canyon that is located along the eastern portion of the Gulf of Mexico. This area has also been identified as an area of increased awareness. This increased awareness area would extend from the shelf break seaward to the 1,600 m (5,249 ft) bathymetric curve. To remain consistent with the methodology utilized in designating similar areas of increased awareness (i.e., Gulf of Mexico canyon areas), a 10 km (5 NM) buffer was added to the area shoreward of the shelf break and a 5 km (3 NM) buffer was added seaward of the 1,600 m (5,249 ft) bathymetric curve.

2.6.5.6 Areas of Persistent Oceanographic Features

The Gulf Stream current is part of the larger Gulf Stream System that includes the Loop Current in the Gulf of Mexico and the Florida Current in the Florida Straits. The Gulf Stream is a powerful surface current that carries warm equatorial waters into the cooler North Atlantic. The Gulf Stream flows roughly parallel to the coastline from the Florida Straits to Cape Hatteras, where it is deflected from the North American continent and flows northeastward past the Grand Banks. This front is a watermass boundary separating cooler and fresher shelf waters from saltier and warmer slope waters (Graziano and Gawarkiewicz, 2005). As with other oceanographic fronts, the convergence of the different water masses concentrates prey species such as plankton and zooplankton. Because prey are abundant, predators, including larger fish, marine mammals, and birds, may also occur in increased numbers (NMFS, 2005a). Haney and McGillavery (1985) suggested increased numbers of Cory's shearwaters observed along the Gulf Stream western front is a result of increased food availability created by physical conditions of the front. The attraction between predators and prey created by the frontal conditions provides for increased commercial and recreational fishing opportunities (NMFS, 2005a). Thus, the area offshore of North Carolina, beginning at the Cape Hatteras Horn and running south along the shelf break midway through the CHPT OPAREA as shown in Figure 2-27 was included as an area of increased awareness.

2.6.5.7 North Atlantic Right Whale Critical Habitat Areas

Critical habitat for the North Atlantic right whale exists along the U.S. East Coast. The following three areas occur in U.S. waters and were designated by NMFS as critical habitat in June 1994 (NMFS, 2005b):

1. Coastal Florida and Georgia (Sebastian Inlet, Florida, to the Altamaha River, Georgia)
2. The Great South Channel, east of Cape Cod
3. Cape Cod and Massachusetts Bays

In order to reduce potential exposures of endangered right whales during their critical calving and feeding activities, the three designated critical habitat would be considered as areas of increased awareness. However, based on operational requirements associated with object detection/navigational sonar training for surface ships and submarines, a 4 km (2 NM) break in the area was included off Mayport, Florida, and Kings Bay, Georgia. In addition, based on operational and safety requirements, the area off Mayport, Florida, will be used for helicopter dipping sonar. Furthermore, a small portion of the TORPEX activity area is located within an area of increased awareness in the Northeast OPAREA that is designated due to the presence of North Atlantic right whale critical habitat. However, TORPEX activities would not occur 5 km (2.7 NM) of the Stellwagen Bank National Marine Sanctuary and would only occur in August and September. This area cannot be relocated due to operational requirements, specifically, proximity to support facilities for recovery operations.

2.6.5.8 River and Bay Mouths

Bay and river mouths are areas where low-salinity waters meet with high-salinity ocean waters. These areas are called mixing zones or the convergence zone (Figure 2-30). Mixing zones occur when the front of the salt wedge meets lower salinity waters flowing out of a bay or river. Mixing zones are typically characterized as areas containing increased levels of suspended particles (i.e., turbidity). The characteristic of increased suspended particles plays a significant role in retaining planktonic organisms, thus creating productive larval fish nursery areas (Chesapeake Biological Laboratory [CBL], 2006). This increased production of larval and juvenile fish provides a natural feeding ground for predatory fish. Thus, the increase in predator fish attracts marine mammals that feed on these large species of fish.

Based on the highly productive nature of these mixing zone areas (i.e., convergence zone) and their role in concentrating larval fish species and marine mammal prey, a 35 km (19 NM) buffer around the mouth of significant bays and rivers would be considered as an area of increased awareness.

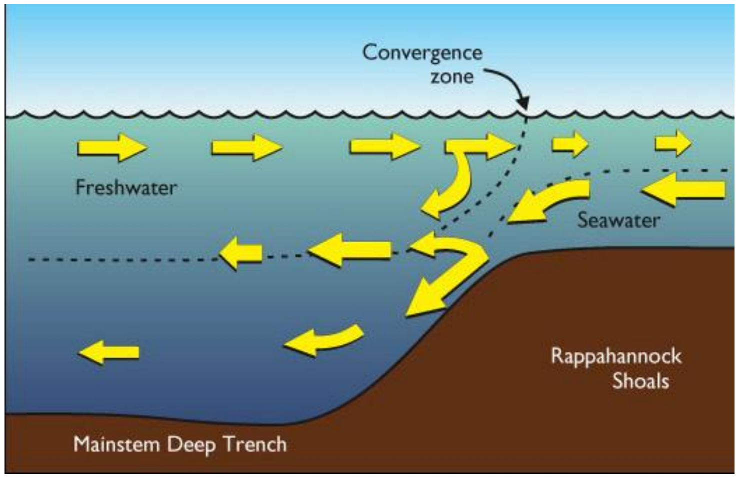


Figure 2-30. Chesapeake Bay Convergence Zone
Source: Boicourt, 2004

2.6.5.9 Areas of High Marine Mammal Density

An additional step taken was to look at high densities of sperm whales, beaked whales, and North Atlantic right whales that may not have been delineated through the identification of other highly productive areas. These marine mammal densities are based on survey work and habitat prediction modeling. The density data used were the same data utilized in the AN/SQS-53 surrogate analysis.

Once the area of increased awareness associated with the biologically sensitive and highly productive areas were designated within geographic information system (GIS) layers, the densities for sperm whales, beaked whales, and North Atlantic right whales were reviewed. This secondary review of the density data focused on areas of higher densities that were not already captured. In the Gulf of Mexico, the sperm whale densities were utilized as the primary driver for identifying additional areas of increased awareness within the Desoto Canyon and other deep water habitat near the Gulf of Mexico. In addition, the North Atlantic right whale, beaked whale, and sperm whale densities were used to review and identify additional areas of increased awareness along the East Coast. However, the beaked whale densities were given priority in the deeper offshore waters of the southeast and mid-Atlantic, while the North Atlantic right whale was given priority for areas on and adjacent to the shelf break. In the Northeast, the identification of additional areas of increased awareness within canyon areas and other deep water habitat focused on sperm whale densities, while the identification of additional areas of awareness on and near the shelf break focused on North Atlantic right whale densities. The majority of additional areas of increased awareness were located seaward of the shelf break and were associated with some type of bottom relief or upwelling. Refer to Appendix D for additional information.

2.6.5.10 Designated National Marine Sanctuaries

There are national marine sanctuaries located within the AFAST Study Area that fall outside already designated habitat areas of increased awareness. These national marine sanctuaries include the following:

- Monitor
- Gray's Reef
- Stellwagen Bank
- Florida Keys
- Flower Garden Banks

The Monitor National Marine Sanctuary was implemented to preserve the famous naval ship. The area encompasses 1.9 km (1 NM) of the shipwreck and the water column surrounding it from the ocean's surface to seafloor. The ship provides habitat for a small, established ecosystem and a number of marine species that pass through the area (National Marine Sanctuary Program [NMSP], 2007d).

Gray's Reef National Marine Sanctuary was established to protect one of the largest live hardbottom (Figure 2-31) areas in the southeastern United States. The live bottom areas of the sanctuary support "an unusual assemblage of temperate and tropical marine flora and fauna." Loggerhead sea turtles use the reef year-round. In addition, North Atlantic right whales use part of the sanctuary as a winter calving area, which is the only known calving area of its kind for this highly endangered species (NOAA, 2007a).

Figure 2-31. Example of Hardbottom Area

Stellwagen Bank National Marine Sanctuary was designated to protect the productivity linked to the benthic and midwater habitats. Invertebrates have cover and anchoring locations here and also a variety of endangered species such as leatherback and Kemp's ridley sea turtles, and the humpback, North Atlantic right, sei, and fin whales use the area as feeding and nursery grounds (NMSP, 2007f).

The Florida Keys National Marine Sanctuary was established to protect important natural and cultural resources. In addition to a colorful diversity of marine life associated with expanses of coral reefs (Figure 2-32), a trail of historic shipwrecks lines the southern boundary of this sanctuary. Mangrove forests occur throughout the land-water interfaces of the numerous islands or keys in the sanctuary, providing habitat, shelter, food, and nursery areas for birds, fish, and invertebrates. Five species of sea turtles, as well as the endangered manatee inhabit the waters of this sanctuary (NOAA, 2007b).

Figure 2-32. Example of Coral Reef

As the northernmost reef in the Gulf of Mexico, the Flower Gardens Banks National Marine Sanctuary was designated to protect the ecological and recreational value of three areas of coral reef that exist atop salt domes arising from the ocean floor. These three areas, East Flower Garden Bank, West Flower Garden Bank, and Stetson Bank, have their own boundaries and are separated from each other by miles of ocean (NOAA, 2007b).

Under Alternative 3, the U.S. Navy will not conduct active sonar activities within the Stellwagen Bank, Monitor, Gray's Reef, Flower Garden Banks, and Florida Keys National Marine Sanctuaries. Though each of these five sanctuaries has established boundaries, to further protect these sensitive areas, the Navy would observe a 5 km (2.7 NM) buffer around each sanctuary.

2.7 PREFERRED ALTERNATIVE

Through careful consideration of the data developed in this EIS/OEIS, and the necessity to conduct realistic ASW training today and in the future, USFF has selected the No Action Alternative as the operationally preferred alternative. The world today is a rapidly changing and extremely complex place. This is especially true in the arena of ASW and the scientific advances in submarine quieting technology. Not only is this technology rapidly improving, the availability of these quiet submarines has also significantly increased. Since these submarines typically operate in coastal regions, which are the most difficult acoustically to conduct ASW, the Navy needs to ensure it has the ability to train in areas that are environmentally similar to where these submarines currently operate, as well as areas that may arise in the future. Limiting where naval forces can train will eliminate this critical option of training flexibility to respond to future crises.

As the biological science continues to evolve, the areas identified in this EIS/OEIS could evolve and change as well, again potentially restricting access to areas that would be critical to training.

Not only would Alternatives 1 and 2 severely limit the necessity to train in areas similar to where potential threats operate, it would require the relocation of approximately 30 percent of Navy's current training. Furthermore, independent of the geographic limitations that would be imposed by Alternative 3, there is not a statistically significant difference in the analytical results (number of exposures) between Alternative 3 and the No Action Alternative. Because the difference in acoustic effects analysis between Alternative 3 and the No Action Alternative is statistically insignificant, and considering the importance of the geographic flexibility required to conduct realistic training, the No Action Alternative was selected as the preferred option.

2.8 COMPARISON OF ATLANTIC FLEET AND PACIFIC FLEET APPROACHES FOR DEVELOPING ALTERNATIVES

The Navy's approach to developing alternatives in this EIS/OEIS for the Atlantic Fleet varies from that discussed in Pacific Fleet environmental planning documents. This EIS/OEIS considers alternatives based on environmental conditions (e.g., marine mammal occurrence and densities, and topographic, geographic, bathymetric conditions) which are different from those encountered in the Pacific Fleet Study Areas. For instance, the Atlantic Fleet Study Area has a much larger shallow-water region available because of the wide continental shelf. The Pacific Fleet Study Areas, in contrast, has very narrow continental shelves, which limit the available shallow-water areas. Thus, Pacific Fleet has limited geographic flexibility. In addition, the majority of Atlantic Fleet active sonar activities occur in open ocean areas. While the Atlantic Fleet also has shore-based support facility requirements for ASW training, they are not concentrated in one geographic area, which provides greater potential for operational flexibility than in the Pacific Fleet Study Areas. The Pacific Fleet, in contrast, has range complexes centered on geographically fixed instrumented ranges and high-value, land-based training ranges (e.g., San Clemente Island and Pacific Missile Range Facility), which limits their overall operational flexibility.

Additional information on the Southern California Range Complex EIS/OEIS and Hawaii Range Complex EIS/OEIS can be located at their respective web pages: http://www.socalrange complexeis.com/default.aspx and http://www.govsupport.us/navynepa hawaii/hawaiirceis.aspx.

2.9 ISSUES ELIMINATED FROM FURTHER CONSIDERATION

Table 2-5 lists issues eliminated from further analysis and provides an explanation for their dismissal.

Table 2-5. Environmental Issues Eliminated from Further Analysis

Issues Eliminated	Reason for Dismissal
Terrestrial Biology	The Proposed Action only addresses active sonar training activities occurring in and over the waters located along the East Coast of the U.S. and in the Gulf of Mexico.
Land Use	
Prime or Unique Farmland	
Parks and Forests Including National Parks	
Wetland Habitat	
Utilities	
Air Quality	The use of active sonar has no potential to affect air quality. Potential air quality effects associated with airborne transportation (i.e., airplanes or helicopters) is being analyzed under the individual TAP EIS/OEISs.

EIS = Environmental Impact Statement; OEIS = Overseas Environmental Impact Statement; TAP = Tactical Training Theater Assessment Planning Program\AFAST EIS/OEIS Summary

2.10 POTENTIAL EFFECTS TO RESOURCE AREAS

Tables 2-6 through 2-8 provide a summary overview of the AFAST EIS/OEIS analysis results for marine habitat, biological and anthropogenic resources.

This page is intentionally blank.

Table 2-6. Summary of Effects – Marine Habitat

Stressor	Marine Habitat Resource		
	Sediment Contamination	**Marine Debris**	**Water Quality**
Sonobuoys			
Metal Subsurface Unit	Potential for the accumulation of chemicals associated with the metal subsurface unit (Section 4.3.1).	Potential for accumulation of expended materials (Section 4.3.2).	Potential effects to water quality as a result of the expended unit (Section 4.3.3).
Parachutes	No anticipated effects.	Potential for accumulation of expended materials (Section 4.3.2).	No anticipated effects.
Sea Water Batteries	Potential for the accumulation of chemicals from the release of the expended battery (Section 4.3.1).	Potential for accumulation of expended materials (Section 4.3.2).	Potential effects to water quality as a result of the expended battery (Section 4.3.3).
Lithium Batteries	Potential for the accumulation of chemicals from the release of the expended battery (Section 4.3.1).	Potential for accumulation of expended materials (Section 4.3.2).	Potential effects to water quality as a result of the expended battery (Section 4.3.3).
Thermal Batteries	Potential for the accumulation of chemicals from the release of the expended battery (Section 4.3.1).	Potential for accumulation of expended materials (Section 4.3.2).	Potential effects to water quality as a result of the expended battery (Section 4.3.3).
Explosive source sonobuoy (AN/SSQ-110A)	Explosive residuals analyzed separately for potential water quality effects (Section 4.3.3).	Potential for accumulation of expended materials (Section 4.3.2).	Potential effects to water quality as a result of the explosion byproducts (Section 4.3.3).
Torpedoes			
OTTO Fuel II	Potential for the accumulation of chemicals from the release of OTTO Fuel II combustion byproducts (Section 4.3.1).	No anticipated effects.	Potential effects to water quality as a result of the release of OTTO Fuel II combustion byproducts (Section 4.3.3).
Guidance Wire	No anticipated effects.	Potential for accumulation of expended materials (Section 4.3.2).	No anticipated effects.
Flex Hoses	No anticipated effects.	Potential for accumulation of expended materials (Sections 4.3.2).	No anticipated effects.

Table 2-6. Summary of Effects – Marine Habitat Cont'd

Stressor	Marine Habitat Resource		
	Sediment Contamination	**Marine Debris**	**Water Quality**
Acoustic Device Countermeasures			
Lithium sulfur dioxide batteries	Potential for the accumulation of chemicals associated with the expended battery cell (Section 4.3.1).	Potential for accumulation of expended materials (Section 4.3.2.	Potential effects to water quality as a result of the expended battery (Section 4.3.3).
Expendable Mobile Acoustic Training Target			
Lithium sulfur dioxide batteries	Potential for the accumulation of chemicals associated with the expended battery cell (Section 4.3.1).	Potential for accumulation of expended materials (Section 4.3.2).	Potential effects to water quality as a result of the expended battery (Section 4.3.3).

Table 2-7. Summary of Potential Effects – Biological Resources

Stressor	Biological Resource							
	Marine Mammals	**Sea Turtles**	**EFH**	**Marine Fish**	**Sea Birds**	**Marine Invertebrates**	**Marine Plants and Algae**	**National Marine Sanctuaries**
Sonar								
Surface Ship Sonar	Potential for exposure to underwater sound (Section 4.4.10).	Potential for exposure, but no anticipated response (Section 4.5.1).	No anticipated effects (Section 4.6).	Potential for exposure to underwater sound (Section 4.7.1).	Potential for exposure, but no anticipated response (Section 4.8.1).	Potential for exposure to underwater sound (Section 4.9.1).	Potential for exposure to underwater sound (Section 4.10.1) , but no anticipated response.	Potential for exposure to underwater sound (Section 4.11).
Mine Warfare Sonar	Potential for exposure to underwater sound (Section 4.4.10).	Potential for exposure, but no anticipated response (Section 4.51).	No anticipated effects (Section 4.6).	Potential for exposure to underwater sound (Section 4.7.1).	Potential for exposure, but no anticipated response (Section 4.8.1).	Potential for exposure to underwater sound (Section 4.9.1).	Potential for exposure to underwater sound (Section 4.10.1) , but no anticipated response.	Potential for exposure to underwater sound (Section 4.11).
Aircraft Dipping Sonar	Potential for exposure to underwater sound (Section 4.4.10).	Potential for exposure, but no anticipated response (Section 4.5.1).	No anticipated effects (Section 4.6).	Potential for exposure to underwater sound (Section 4.7.1).	Potential for exposure, but no anticipated response (Section 4.8.1).	Potential for exposure to underwater sound (Section 4.9.1).	Potential for exposure to underwater sound (Section 4.10.1) , but no anticipated response.	Potential for exposure to underwater sound (Section 4.11).
Submarine Sonar	Potential for exposure to underwater sound (Section 4.4.10).	Potential for exposure, but no anticipated response (Section 4.5.1).	No anticipated effects (Section 4.6).	Potential for exposure to underwater sound (Section 4.7.1).	Potential for exposure, but no anticipated response (Section 4.8.1).	Potential for exposure, but no anticipated response.	Potential for exposure to underwater sound (Section 4.10.1) , but no anticipated response.	Potential for exposure to underwater sound (Section 4.11).
Sonobuoys								
Tonal (AN/SSQ-62)	Potential for exposure to underwater sound (Section 4.4.10).	Potential for exposure, but no anticipated response (Section 4.5.1).	No anticipated effects (Section 4.6).	Potential for exposure to underwater sound (Section 4.7.1).	Potential for exposure, but no anticipated response (Section 4.8.1).	Potential for exposure to underwater sound (Section 4.9.1).	Potential for exposure to underwater sound (Section 4.10.1) , but no anticipated response.	Potential for exposure to underwater sound (Section 4.11).

Table 2-7. Summary of Potential Effects – Biological Resources Cont'd

Stressor	Biological Resource							
	Marine Mammals	Sea Turtles	EFH	Marine Fish	Sea Birds	Marine Invertebrates	Marine Plants and Algae	National Marine Sanctuaries
Explosive source sonobuoy (AN/SSQ-110A)	Potential for exposure to impulsive sound (Section 4.4.10).	Potential for exposure to impulsive sound (Section 4.5.2).	Potential for exposure to impulsive sound (Section 4.6).	Potential for exposure to impulsive sound (Section 4.7.2).	Potential for exposure, but no anticipated response (Section 4.8.2).	Potential for exposure to impulsive sound (Section 4.9.2).	Potential for exposure to impulsive sound (Section 4.10.2) , but no anticipated response.	Potential for exposure to impulsive sound (Section 4.11).
Listening (AN/SSQ-53 and AN/SSQ-101)	No potential exposure to sound.	No potential exposure to sound.	No anticipated effects (Section 4.6).	No potential exposure to sound.	No potential exposure to sound.	No potential exposure to sound.	No potential exposure to sound.	No potential exposure to sound.
Aircraft Generated Sound								
Aircraft generated sound	Potential for exposure to underwater sound (Section 4.4.11).	Potential for exposure, but no anticipated response.	No anticipated effects (Section 4.6).	Potential for exposure, but no anticipated response.	Potential for exposure, but no anticipated response.	Potential for exposure, but no anticipated response.	Potential for exposure, but no anticipated response.	Potential for exposure, but no anticipated response.
Non-Acoustical								
Vessel Strikes	Potential for injury from vessel interaction (Section 4.4.12).	Potential for injury from vessel interaction (Section 4.5.3).	Potential for injury from vessel interaction	No anticipated injury from vessel interaction.	No anticipated injury from vessel interaction.	No anticipated injury from vessel interaction.	No anticipated injury from vessel interaction.	Potential for species injury from vessel interaction (Section 4.11).
Expended Materials								
Sonobuoy Parachutes	Potential for entanglement or ingestion (Section 4.4.12).	Potential for entanglement (Section 4.5.3).	Potential for injury from expended material.	No anticipated entanglement.	Potential for entanglement (Section 4.8.4).	No anticipated entanglement.	No anticipated entanglement.	Potential for species entanglement (Section 4.11).

Table 2-7. Summary of Potential Effects – Biological Resources Cont'd

Stressor	Biological Resource							
	Marine Mammals	Sea Turtles	EFH	Marine Fish	Sea Birds	Marine Invertebrates	Marine Plants and Algae	National Marine Sanctuaries
Torpedoes	Potential for direct contact (Section 4.4.12).	Potential for direct contact (Section 4.5.3).	Potential for injury from expended material.	No anticipated contact.	No anticipated contact.	No anticipated contact.	No anticipated contact.	Potential for direct contact (Section 4.11).
Torpedo Guidance Wire	Potential for entanglement (Section 4.4.12).	Potential for entanglement (Section 4.5.3).	Potential for injury from expended material.	No anticipated entanglement.	No anticipated entanglement.	No anticipated entanglement.	No anticipated entanglement.	Potential for species entanglement (Section 4.11).
Torpedo Flex Hoses	Potential for entanglement (Section 4.4.12).	Potential for entanglement (Section 4.5.3).	Potential for injury from expended material.	No anticipated entanglement	No anticipated entanglement.	No anticipated entanglement.	No anticipated entanglement.	Potential for species entanglement (Section 4.11).
Acoustical Device Countermeasures	Potential for direct contact (Section 4.4.12).	Potential for direct contact (Section 4.5.3).	Potential for injury from expended material.	No anticipated contact.	No anticipated contact.	No anticipated contact.	No anticipated contact.	Potential for species direct contact (Section 4.11).
Expendable Mobile Acoustic Training Targets	Potential for direct contact (Section 4.4.12).	Potential for direct contact (Section 4.5.3).	Potential for injury from expended material.	No anticipated contact.	No anticipated contact.	No anticipated contact.	No anticipated contact.	Potential for species direct contact (Section 4.11).

Table 2-8. Summary of Effects – Anthropogenic

Stressor	Anthropogenic Resource							
	Airspace Management	Energy	Recreational Boating	Commercial and Recreational Fishing	Commercial Shipping	SCUBA Diving	Marine Mammal Watching	Cultural Resources
Availability of Ocean and Airspace	No effect.	Potential for conflict with energy development (Section 4.13).	Potential for interaction with non-military vessels (Section 4.14).	Potential for area closures (Section 4.15).	Potential for interaction with non-military vessels (Section 4.16).	Potential for interaction and diver exposure to active sonar (Section 4.17).	Potential for interaction with non-military vessels (Section 4.18).	No potential exposure.
Expended Materials	No effect.	No potential exposure.	No potential exposure.	No potential exposure.	No potential exposure.	No potential exposure.	No potential exposure.	Potential for disturbance to cultural resources (Section 4.19).

3. AFFECTED ENVIRONMENT

3.1 INTRODUCTION

The environmental parameters provided in this chapter serve as the baseline from which to compare the potential effects of the Proposed Action considered in this Atlantic Fleet Active Sonar Training (AFAST) Environmental Impact Statement/Overseas Environmental Impact Statement (EIS/OEIS). The environmental parameters presented in this chapter correspond to the resource discussions contained in Chapter 4, Environmental Consequences. The improved extended echo ranging (IEER) system consists of an explosive source sonobuoy (AN/SSQ-110A) and an air deployable active receiver (ADAR) sonobuoy (AN/SSQ-101). This chapter describes the physical, biological, and human resources that could be affected by the Proposed Action. The resources addressed in this chapter include the following:

- Physical environment – geophysical features, current flow, temperature, and salinity.
- Biological environment – marine mammals, sea turtles, fish, seabirds, marine invertebrates, marine plants and algae, and National Marine Sanctuaries (NMS).
- Airspace management.
- Energy – water, wind, oil, and gas.
- Socioeconomic conditions – data on commercial and recreational fishing and boating, commercial shipping, scuba diving, and marine mammal watching.
- Cultural resources – archaeological and historical assets.

The AFAST Study Area encompasses the waters and their associated substrates along the East Coast of the United States (U.S.) and in the Gulf of Mexico (GOMEX) as depicted in Figure 1-2. The Study Area has been separated into the following geographic regions:

- Atlantic Ocean, Offshore of the Southeastern United States (i.e., Virginia Capes [VACAPES] Operating Area (OPAREA), Cherry Point [CHPT] OPAREA, and the Jacksonville/ Charleston [JAX/CHASN] OPAREA.
- Atlantic Ocean, Offshore of the Northeastern United States. (i.e., Boston OPAREA, Narragansett Bay OPAREA, and Atlantic City OPAREA).
- Eastern GOMEX (i.e., waters offshore of Louisiana, Mississippi, Alabama, and western Florida).
- Western GOMEX (i.e., waters offshore of Texas).

The delineation between U.S. territorial waters (shoreline to 22 kilometers [km] or 12 nautical miles [NM]) and non-territorial waters (22 km [12 NM] and beyond) is not distinguished in this chapter; instead, the natural and human environment is described using physical parameters, such as sediment type or water quality, which do not follow political boundaries.

3.2 BEST AVAILABLE DATA

The Navy used the best available information to compile the environmental baseline included in this chapter and to conduct the analyses included in Chapter 4. Further, the Navy ensures that the information incorporated into this EIS/OEIS is readily available to the public.

The statutes (National Environmental Policy Act of 1969 [NEPA], Executive Order [EO] 12114, the Data Quality Act, and the Administrative Procedures Act) require that federal agencies use the best available data. Hence, the data included in this EIS/OEIS represent the circumstances and methodologies that appropriate regulatory and scientific communities have accepted as the precedent and standard for the analyses of the specific resource areas. The authors assessed the quality of the identified data including those references exhibiting utility (usefulness), integrity (protected and secure from unauthorized access or revision to avoid corruption or falsification), and objectivity (accurate, reliable information presented in clear, complete, and unbiased manner). The following sections provide specific information on the types of information used, including (where appropriate) an overview of how authors found and incorporated the data.

3.2.1 Navy Marine Resource Assessment Program

The Navy Marine Resource Assessment (MRA) Program was implemented by the Commander, Fleet Forces Command, to initiate collection of data and information concerning the protected and commercial marine resources found in the Navy's OPAREAs. Specifically, the goal of the MRA program is to describe and document the marine resources present in each of the Navy's OPAREAs. MRAs have been completed for the Northeast, VACAPES, CHPT, JAX/CHASN, and the GOMEX OPAREAs (Department of the Navy [DON], 2005, 2007a, 2007b, 2007c, and 2007d).

These MRAs represent a compilation and synthesis of available scientific literature (e.g., journals, periodicals, theses, dissertations, project reports, and other technical reports published by government agencies, private businesses, scientists and engineers, or consulting firms), and National Marine Fisheries Service (NMFS) reports including stock assessment reports, recovery plans, and survey reports. The MRAs provide a summary of the physical environment (e.g., marine geology, circulation and currents, hydrography, and plankton and primary productivity) for the AFAST Study Area. In addition, the MRAs provide an in-depth discussion of the biological environment (marine mammals, sea turtles, fish, and essential fish habitat [EFH]), as well as fishing grounds (recreational and commercial), and other areas of interest (such as maritime boundaries, navigable waters, marine managed areas, and recreational diving sites).

3.2.2 Marine Species Density Determinations

The density estimates that were used in previous Navy environmental documents have been recently updated to provide a compilation of the most recent data and information on the occurrence, distribution, and density of marine mammals and sea turtles in the southeast OPAREAs. The updated density estimates presented in this EIS/OEIS are derived from the *Navy OPAREA Density Estimates (NODE) for the Northeast OPAREAs* report (DON, 2007c), the

NODE for the Southeast OPAREAs report (DON, 2007a), and the *NODE for the GOMEX OPAREA* report (DON, 2007b).

Density estimates for cetaceans were either modeled for each region (Northeast, Southeast, and GOMEX) using available line-transect survey data or derived in order of preference: 1) through spatial models using line-transect survey data provided by NMFS; 2) using abundance estimates from Mullin and Fulling (2003), Fulling et al. (2003), and/or Mullin and Fulling (2004); 3) or based on the cetacean abundance estimates found in the most current NOAA stock assessment report (SAR) (Waring et al., 2007). In the AFAST Study Area, density estimates were derived as follows:

1. Northeast OPAREAs: the traditional line-transect methods used in the Northeast NODE (Palka, 2005a, 2005b; DON, 2007h) and abundance estimates from the North Atlantic Right Whale Consortium (NARWC, 2006). Density estimates for pinnipeds in these OPAREAs were derived from abundance estimates found in the NOAA stock assessment report (Waring et al., 2007) or from the scientific literature (Barlas, 1999).
2. Southeast OPAREAs: abundance estimates found in the National Oceanic and Atmospheric Administration (NOAA) stock assessment report (Waring et al., 2007) or in Mullin and Fulling (2003).
3. GOMEX OPAREAs: abundance estimates found in the NOAA stock assessment report (Waring et al., 2007) based on Mullin and Fulling (2004).

For the model-based approach, density estimates were calculated for each species within areas containing survey effort. A relationship between these density estimates and the associated environmental parameters such as depth, slope, distance from the shelf break, sea surface temperature (SST), and chlorophyll *a* (chl *a*) concentration was formulated using generalized additive models (GAMs). This relationship was then used to generate a two-dimensional density surface for the region by predicting densities in areas where no survey data exist. For the Northeast, all analyses for cetaceans were based on data collected through NMFS Northeast Fisheries Science Center (NMFS-NEFSC) aerial surveys conducted between 1998 and 2005. For the Southeast, all analyses for cetaceans were based on sighting data collected through shipboard surveys conducted by NMFS-NEFSC and Southeast Fisheries Science Center (NMFS-SEFSC) between 1998 and 2005. For the GOMEX, all analyses for cetaceans were based on data collected through NMFS-SEFSC shipboard surveys conducted between 1996 and 2004. Species-specific density estimates derived through spatial modeling were compared with abundance estimates found in the most current NOAA SAR to ensure consistency. All spatial models and density estimates were reviewed by NMFS technical staff.

For each region, a list of each species and how their density was derived is shown in Tables 3-1 through 3-3. It is important to note that various factors influence the detectability of marine mammals at sea including animal behavior and appearance, group size, blow characteristics, dive characteristics and dive interval, viewing conditions (sea state, wind speed, wind direction, sea swell, and glare); observer experience, fatigue, and concentration; and vessel platform characteristics (pitch, roll, yaw, speed, and height above water). Because certain species can dive for long periods of time, their sightability/detectability during surface surveys can be diminished, which leads to underestimated density. The density estimates detailed in the NODE reports are not corrected for dive times and may be underestimates for some species. For a more detailed description of the methodology involved in calculating the density estimates provided in this EIS/OEIS, please refer to each of the NODE reports (DON, 2007a, 2007b, 2007c).

Table 3-1. Method of Density Estimation for Each Species/Species Group in the Northeast Operating Areas

Species/Species Group
Model-Derived Density Estimates
Humpback whale (*Megaptera novaeangliae*)
Fin whale (*Balaenoptera physalus*)
Minke whale (*Balaenoptera acutorostrata*)
Common dolphin (*Delphinus delphis*)
Atlantic White-sided dolphin (*Lagenorhynchus acutus*)
Harbor porpoise (*Phocoena phocoena*)
Kemp's ridley turtle (*Lepidochelys kempii*)
Leatherback turtle (*Dermochelys coriacea*)
Loggerhead turtle (*Caretta caretta*)
Hardshell Turtles
Density Estimates from Preliminary NE NODE Report
Sei whale (*Balaenoptera borealis*)
Sperm whale (*Physeter macrocephalus*)
Beaked whales (Family Ziphiidae)
Bottlenose dolphin (*Tursiops truncatus*)
Spotted dolphins (*Stenella attenuata and Stenella frontalis*)
Striped dolphin (*Stenella coeruleoalba*)
Risso's dolphin (*Grampus griseus*)
Pilot whales (*Globicephala* spp.)
Gray seal (*Halichoerus grypus*)
Harbor seal (*Phoca vitulina*)
Literature Derived Density Estimates
North Atlantic Right Whale (*Eubalaena glacialis*)
Species for Which Density Estimates Are Not Available
Blue whale (*Balaenoptera musculus*)
Spinner dolphin (*Stenella longirostris*)
White-Beaked Dolphin (*Lagenorhynchus albirostris*)
Pygmy killer whale (*Feresa attenuata*)
Killer whale (*Orcinus orca*)
Harp seal (*Pagophilus groenlandicus*)
Hooded seal (*Cystophora cristata*)

Source: DON, 2007c

Table 3-2. Method of Density Estimation for Each Species/Species Group in the Southeast Operating Areas

Species/Species Group
Model-Derived Density Estimates
Fin whale (*Balaenoptera physalus*)
Sperm whale (*Physeter macrocephalus*)
Beaked Whales (Family Ziphiidae)
Bottlenose dolphin (*Tursiops truncatus*)
Atlantic spotted dolphin (*Stenella frontalis*)
Striped dolphin (*Stenella coeruleoalba*)
Common dolphin (*Delphinus delphis*)
Risso's dolphin (*Grampus griseus*)
Pilot Whales (*Globicephala* spp.)
Leatherback turtle (*Dermochelys coriacea*)
Kemp's ridley turtle (*Lepidochelys kempii*)
Loggerhead turtle (*Caretta caretta*)
Hardshell Turtles
SAR or Literature-Derived Density Estimates
North Atlantic Right Whale (*Eubalaena glacialis*)[1]
Humpback whale (*Megaptera novaeangliae*)[1]
Minke whale (*Balaenoptera acutorostrata*)[2]
Kogia spp.[2]
Rough-toothed dolphin (*Steno bredanensis*)[2]
Pantropical spotted dolphin (*Stenella attenuata*)[2]
Clymene dolphin (*Stenella clymene*)[2]
Species for Which Density Estimates Are Not Available
Blue whale (*Balaenoptera musculus*)
Sei whale (*Balaenoptera borealis*)
Bryde’s whale (*Balaenoptera brydei/edeni*)
Killer whale (*Orcinus orca*)
Pygmy killer whale (*Feresa attenuata*)
False killer whale (*Pseudorca crassidens*)
Melon-headed Whale (*Peponocephala electra*)
Spinner dolphin (*Stenella longirostris*)
Fraser’s dolphin (*Lagenodelphis hosei*)
Harbor porpoise (*Phocoena phocoena*)

[1] Abundance estimates were geographically and seasonally partitioned
[2] Abundance estimates were uniformly distributed geographically and seasonally
Source: DON, 2007a

Table 3-3. Method of Density Estimation for Each Species/Species Group in the GOMEX Operating Areas

Species/Species Group
Model-Derived Density Estimates
Sperm whale (*Physeter macrocephalus*)
Kogia spp.
Beaked Whales (Family Ziphiidae)
Rough-toothed dolphin (*Steno bredanensis*)
Bottlenose dolphin (*Tursiops truncatus*)
Pantropical spotted dolphin (*Stenella attenuata*)
Atlantic spotted dolphin (*Stenella frontalis*)
Striped dolphin (*Stenella coeruleoalba*)
Spinner dolphin (*Stenella longirostris*)
Risso's dolphin (*Grampus griseus*)
Leatherback turtle (*Dermochelys coriacea*)
Loggerhead turtle (*Caretta caretta*)
Hardshell Turtles
SAR or Literature-Derived Density Estimates
Bryde's whale (*Balaenoptera brydei/edeni*)
Clymene dolphin (*Stenella clymene*)
Fraser's dolphin (*Lagenodelphis hosei*)
Killer whale (*Orcinus orca*)
False killer whale (*Pseudorca crassidens*)
Pygmy killer whale (*Feresa attenuata*)
Melon-headed Whale (*Peponocephala electra*)
Short-finned pilot whale *(Globicephala macrorhynchus)*

Source: DON, 2007b

Abundance is the total number of individuals that make up a given stock as in NMFS SARs, or the total number estimated within a particular study area as in Mullin and Fulling (2003). NMFS stock abundances for most species represent the total estimate of individuals within the geographic area, if wholly known, that comprises that stock. For some species, this geographic area may extend beyond U.S. waters. Survey abundances are the total individuals estimated within the survey study area, which may or not align completely with a stock's geographic range as defined in the SARs. These surveys may also extend beyond U.S. waters. Both stock abundance and survey abundance are used in this EIS/OEIS to determine a density of marine mammal species within the AFAST Study Area. That some portion of the animals range may extend beyond the AFAST Study Area or U.S. waters is irrelevant to the concentration of animals that could be present within the AFAST Study Area at a given time. It is this concentration or density that is most important for conducting the analysis of effects from AFAST active sonar activities.

3.2.3 Primary Literature

The preparers of this EIS/OEIS conducted a number of literature searches using *Science Direct®*, *High Wire Press®*, *Directory of Open Access Journals*, and the *Journal of the Acoustical Society of America-Online (JASA-O)*. *Science Direct®* databases provide access to more than 8 million articles in over 2,000 journals focused on the physical sciences and engineering; life sciences;

health sciences; and social sciences and humanities. *High Wire Press*® offers access to nearly 4.3 million articles published by approximately 1,040 journals. Topics for journals in these databases include biological, social, medical, physical sciences, and the humanities. The *Directory of Open Access Journals* includes peer-reviewed scientific and scholarly publications that are available to the public free of charge. The searches of each database included general queries in the resource areas of and potential effects to marine species (marine mammals, sea turtles, fish, and birds), socioeconomics (fisheries, tourism, boating, and diving), natural resources (oil and gas), artificial reefs, whale and dolphin watching, and cultural resources. Finally, *JASA-O* offers search capabilities for and access to articles as early as 1929. Searches for articles available from this journal included focused information on hearing capabilities and potential effects to marine species such as marine mammals, sea turtles, fish, and diving birds.

3.2.4 Government Publications

This document refers to information from other government agency publications in addition to the MRAs and NODEs. The primary focus of this EIS/OEIS is on the marine environment; therefore, resource area experts obtained information available from NMFS, an agency that regulates the majority of oceanic and estuarine water resources. A number of publications are available through NMFS and concentrate on various resource areas, including statistics for commercial and recreational fishing, lists of endangered and threatened species, and stock assessment reports for marine mammals. Some of the most comprehensive information for establishing the environmental baseline for this EIS/OEIS came from Environmental Assessments and EISs conducted by the Minerals Management Service (MMS) throughout various portions of the AFAST Study Area. This chapter also incorporates applicable data from various state and local agencies.

3.2.5 Other Data Sources

The Navy conducted internet searches using search engines Google®, Yahoo®, and Dogpile® and key word searches to obtain information on the environmental baseline for this EIS/OEIS. Examples of specific keywords searched include “wind farms,” “liquefied natural gas,” and specific ports associated with the various regions of the AFAST Study Area. The searches produced a number of websites that the authors evaluated for credibility of the source, quality of the information, and relevance of the content. As previously stated, the preparers of this EIS/OEIS included only the best available information into this document.

3.3 OCEANOGRAPHY

The oceanographic features in the AFAST Study Area, including water currents (Figure 3-1), characteristics (i.e., temperature, salinity), and bathymetry (Figure 3-2) are described below. While the oceanography of the area would not be affected by the Proposed Action, these features affect the spatial and temporal extent of other resources discussed in the EIS/OEIS.

3.3.1 Currents

Wind and water density differences drive the circulation or movement of currents or water masses in the oceans. Surface currents are horizontal movements primarily driven by the drag of the wind over the water surface. Wind-driven circulation affects the upper 100 meters (m) (328 feet [ft]) of the water column. Variations in temperature and salinity cause differences in water density; these differences drive thermohaline or vertical circulation. Thermohaline circulation causes movement in water masses at all levels (deep and surface) of the water column.

The Gulf Stream System has a pronounced influence on the Study Area. The western continental margin of any ocean basin is the location of intense boundary currents. The Gulf Stream is the western boundary current of the North Atlantic Ocean. The Gulf Stream is part of a larger current system called the Gulf Stream System, which also includes the Loop Current in the Gulf of Mexico and the Florida Current in the Atlantic, between the Straits of Florida and Cape Hatteras. The Gulf Stream is a powerful surface current, carrying warm water into the cooler North Atlantic, and exerting a considerable influence on the oceanographic conditions in each OPAREA. This section provides detailed information regarding the currents of the specific OPAREAs that comprise the AFAST Study Area.

3.3.1.1 Atlantic Ocean, Offshore of the Southeastern United States

The Gulf Stream exerts a considerable influence on the oceanographic conditions in the VACAPES OPAREA. After the Gulf Stream separates from the East Coast in North Carolina, the current passes through the southeastern portion of the VACAPES OPAREA. In this area, the Gulf Stream is approximately 50 km (27 NM) wide and 1,000 m (3,280 ft) deep. Surface velocity ranges from 3.7 to 9.3 kilometers per hour (km/hr) (2.0 to 5.0 knots [kn]), and temperature ranges from 25 to 28^{o}C (77 to 82^{o}F).

Additional surface water masses found in the VACAPES OPAREA are Chesapeake Bay plume water, Delaware Bay plume water, and mid-Atlantic shelf water. Relatively fresh or brackish water from the Chesapeake and Delaware Bays flows out of these estuaries in the form of plume water. This less-dense (due to its lower salinity) water flow turns south, resulting in southward-flowing, coastally trapped currents. An increase in river flow and ebbing tides force more water out of the respective bays; thus, the seaward front of the plume extends across the shelf. During the summer months, predominant southwesterly winds cause a seaward expansion of the plume over the continental shelf, creating a well-stratified, two-layer system. The warm surface waters are replaced by deeper, more saline nutrient-rich water.

The continental shelf waters of the CHPT OPAREA are typical of coastal South Atlantic Bight (SAB) waters and can be subdivided into three distinct flow regimes: the inner shelf, mid-shelf, and outer shelf. Due to river runoff, the inner shelf (0 to 20 m [0 to 66 ft]) is characterized by a band of relatively low salinity. Local wind action influences the flow and sea level variability. Surface and bottom currents on the inner shelf are weak (less than 0.2 km/hr [less than 0.1 kn) and variable in direction. The Gulf Stream influences the outer shelf in the CHPT OPAREA. Prevailing winds and centripetal force cause surface waters to move in a circular fashion in ocean basins.

The Gulf Stream is the dominant surface water mass in the SAB and the JAX/CHASN OPAREA. Southerly flowing currents, that are typical north of Cape Hatteras, are transient events in the SAB and, when present, are limited to the area along the coast. Circulation over the continental shelf in the SAB is typified by a broad, slow, northerly flow of water, with frequent intrusions of the Gulf Stream onto the shelf.

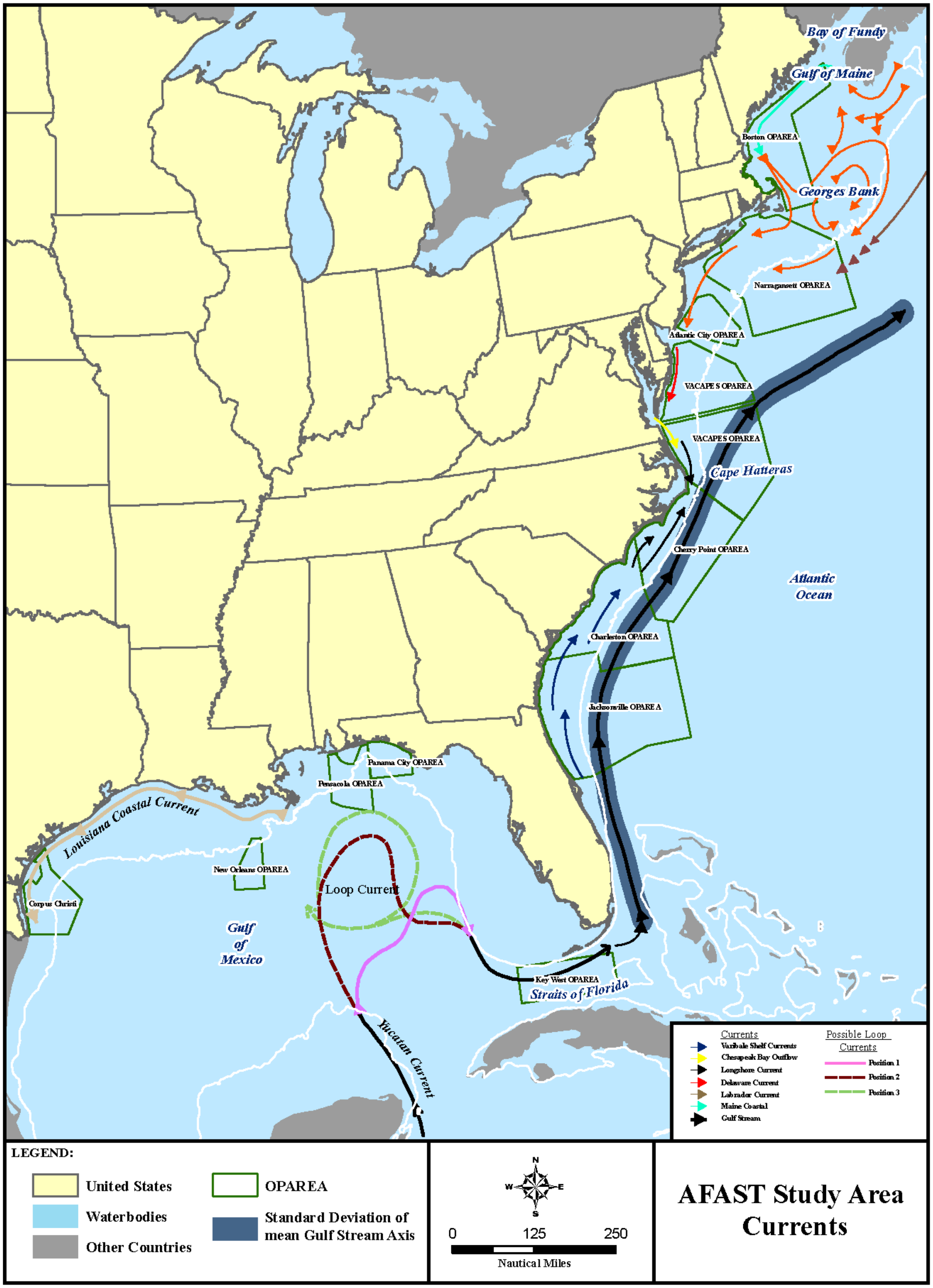


Figure 3-1. AFAST Study Area Water Currents

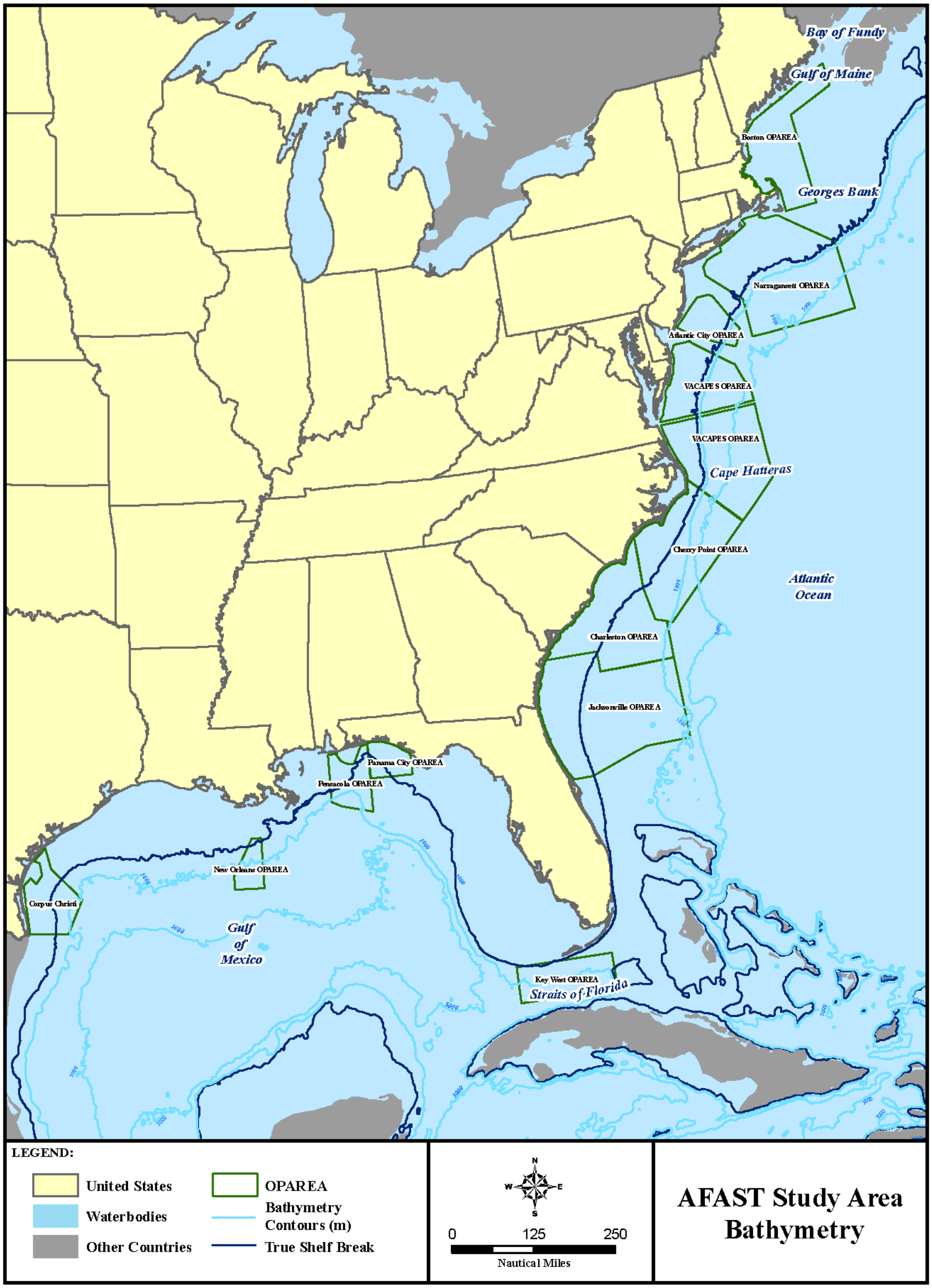


Figure 3-2. AFAST Study Area Bathymetry

As the Gulf Stream enters the JAX/CHASN OPAREA at a water depth of less than 100 m (328 ft), it is fairly narrow and clearly defined. The current travels northward and eastward through the OPAREA and expands to approximately 50 km (27 NM) wide and more than 500 m (1,640 ft) deep. In the SAB, wavelike meanders and cyclonic eddies are consistent features of the Gulf Stream front. These frontal eddies are formed from the large warm and cold core rings that pinch off from the Gulf Stream after it is deflected from the U.S. coast. Frontal eddies commonly occur in areas where the Gulf Stream is far from the coast (e.g., off the coast of northern Florida and Georgia).

In deep waters within the SAB, currents flow in directions opposite to those of the Gulf Stream. The Deep Water Boundary Current is composed of several cold, deep-water masses, each with a characteristic temperature and salinity. The Deep Water Boundary Current flows southward towards the equator at depths between 800 and 4,000 m (2,620 and 13,120 ft) along the eastern flank of the Blake Plateau.

3.3.1.2 Atlantic Ocean, Offshore of the Northeastern United States

The northern part of the Study Area is located near the terminal end of the Labrador Current, the large density-driven coastal current that extends from the west coast of Greenland to the upper Mid-Atlantic Bight (MAB). The upper MAB region is a transition zone between the warm waters of the Gulf Stream Current and the cold, polar Labrador Current to the northeast. As the Labrador Current enters the Study Area, it becomes denser and sinks to the subsurface, to depths of 1,400 to 1,600 m (4,593 to 5,249 ft), transitioning into the Labrador Intermediate Water.

The Gulf of Maine and Bay of Fundy are well known for their extreme semi-diurnal tidal fluctuations, leading to some of the highest tidal heights in the world (15 m [49 ft] in the upper Bay of Fundy). As the tidal pulse enters and spreads through the Gulf of Maine, the tidal movement exhibits a wavelike nature. This “tidal wave” enters the Gulf and moves along the Scotian Shelf into the Bay of Fundy, where it reaches the head of the bay and is reflected southwestward out of the bay toward Cape Cod. Tidal currents in the Gulf of Maine rotate, usually clockwise in the eastern Gulf of Maine. This vigorous tidal turbulence causes the waters of Georges Bank, the Scotian Shelf, and the Bay of Fundy to remain well mixed.

Relatively cold, low-salinity water enters the Gulf of Maine at the surface from the Scotian Shelf, which mixes with cold, tidally mixed waters of the eastern Gulf of Maine, and discharges from the Bay of Fundy to form the Maine Coastal Current (MCC). The MCC flows counterclockwise in the Gulf of Maine until it reaches Penobscot Bay, where it splits into two currents: one flowing south through the Great South Channel and one moving eastward along the northern flank of Georges Bank. Warmer, more saline, nutrient-rich slope water enters the Gulf of Maine at depth through the Northeast Channel. This incoming slope water flows into the deep basins of the Gulf of Maine and mixes with water from the Scotian Shelf to form Maine Bottom Water. It is the coupling of the basins in the Gulf of Maine flooding with dense slope water adjacent to the less dense MCC that creates a pressure gradient leading to cyclonic (counterclockwise) flow of the waters in the Gulf of Maine. When the amount of freshwater input into the Gulf of Maine is high, this counterclockwise circulation can be disrupted, causing the gyre to move in the opposite direction.

The Scotian Shelf water that enters the Gulf of Maine can vary in temperature and salinity depending upon the extent that the Labrador Slope Water (Labrador Intermediate Water) intrudes onto the shelf. During negative Atlantic Ocean Oscillation (NAO) phases, this colder, fresher slope water has spread through the basins of the Gulf of Maine and even onto Georges Bank. The anticyclonic (clockwise) waters on and around Georges Bank as well as those flowing out of the Gulf of Maine through the Great South Channel, are part of a generally southwesterly flowing coastal current system that extends from Newfoundland to Cape Hatteras.

The waters on Georges Bank move in a clockwise direction with the major portion of the flow continuing westward onto the shelf of the MAB. The rotary current on the bank is the result of the strong semidiurnal tidal flow, which causes the waters on the crest of Georges Bank to remain well mixed and promotes high primary productivity. Part of the bank water re-circulates to form a closed gyre on and around the bank. Nutrients and plankton are transported by the movement of water from the Gulf of Maine onto Georges Bank and off the bank into the MAB shelf waters. Other processes, in addition to the MCC waters flowing northward around Georges Bank, are responsible for bringing new water flow (and biota) onto the bank.

Georges Bank has major frontal boundaries surrounding the periphery of the bank and the slope to the south and those of the Gulf of Maine to the north, as well as a tidal mixing front located near the 60-m (196.9-ft) isobath on the crest of the bank. The exchange that occurs across these fronts influences the nutrient supply for primary production, the retention of plankton (including fish and copepod larvae on the bank), and the trophic (nutritional) dynamics of these productive waters. Frontal boundaries often concentrate plankton, which are a food source for larval fish and baleen whales.

The Gulf Stream Current is the western boundary current found in the North Atlantic Ocean. It is part of a larger current system called the Gulf Stream System that also includes the Loop Current in the GOMEX, the Florida Current in the Florida Straits, and the North Atlantic Current in the central North Atlantic Ocean. The Gulf Stream Current is a powerful surface current, carrying warm water into the cooler North Atlantic just south of the Study Area. Surface velocities range from 3.7 to 9.3 kilometers/hour (km/hr) (2 to 5 kn), and the temperature is generally 25 to 28°C (77 to 82.4°F). The Gulf Stream is usually sharply defined on its west and north sides (or walls) but much less so on its east or south sides.

The Gulf Stream flows roughly parallel to the coastline from the Florida Straits to Cape Hatteras, where it is deflected away from the North American continent and flows northeastward past the Grand Banks. The Gulf Stream's path in the North Atlantic varies on a timescale of approximately nine months. While stratification of the water column and other factors may play a role, the variability of the Gulf Stream position is likely due to instability of its mean path in the Cape Hatteras area as well as to climatic variability such as the NAO.

Wave-like meandering begins to occur at Cape Hatteras and increases as the current travels north. North of Cape Hatteras, meanders form small gyres that become separated from the Gulf Stream as either warm- or cold-core rings. Warm-core rings are separated anticyclonic meanders of the Gulf Stream, resulting in a separated deep pool of warm Sargasso Sea water rotating clockwise north of the Gulf Stream. Warm-core rings bring warm water and associated plankton, including ichthyoplankton, to the colder areas of the northeast shelf. Cold-core rings form when a cyclonic meander pinches off from the Gulf Stream, resulting in a counterclockwise rotating ring of cool slope water in the warm Sargasso Sea. Twice as many cold-core rings than warm-core rings are formed per year. The cold-core rings are larger (100 to 300 km [54 to 162 NM]) across and longer lasting (months to years) than warm-core rings Newly formed cold-core rings also drift in a south/southwesterly direction west of 50°W and north of 30°N, south of the Gulf Stream. Cold-core rings also eventually dissipate or merge with the Gulf Stream.

Seamounts, such as the New England Seamount Chain, cause perturbations (disturbances) in the circulation and thermohaline structure of the Gulf Stream. These topographic features (seamounts) cause the current to be deflected around them; the meanders often increase downstream of the seamounts, while cyclonic and anticyclonic deflections occur near the seamounts.

3.3.1.3 Eastern Gulf of Mexico

The major current in the eastern GOMEX is the Loop Current, the upstream extension of the Gulf Stream system. The Yucatan Current enters the eastern GOMEX through the Yucatan Strait between Mexico and Cuba and exits through the Florida Straits as the Florida Current. The flow between these passages exhibits, in a nearly annual cycle, an expansive loop of clockwise flow into the GOMEX. The direction of flow of the Loop Current is highly variable. At one extreme position, the Loop Current flows in a nearly direct path along the northwest coast of Cuba to the Florida Straits. At the other extreme, the current forms an intense clockwise flow that extends as far north as 29°N, at times reaching the Mississippi-Alabama shelf or the west Florida shelf.

As the Loop Current expands northward into the eastern GOMEX, frontal eddies develop along its edge. These tongues of relatively warm Loop Current water propagate eastward until reaching the west Florida shelf, where they turn southward. Irregular intrusions by both the frontal eddies and the Loop Current itself, in addition to river discharges and coastal runoff, influence the waters of the Mississippi-Alabama shelf and the west Florida shelf, enhancing the cross-shelf exchange of heat, energy, and nutrients.

3.3.1.4 Western Gulf of Mexico

Loop current eddies are major current mechanisms in the deeper waters of the western GOMEX. Loop current eddies are rings of counterclockwise circulation that randomly break off from the main body of the Loop Current and drift slowly westward. Typically, the eddies range from 200 to 300 km (108 to 162 NM) across, with a vertical depth of 1,000 m (3,281 ft). They slowly rotate approximately 2.9 to 7.2 km/hr (1.5 to 3.9 kn) and drift westward at a rate of 2 to 5 km (1 to 3 NM) per day (Oey et al., 2005). Also known as warm-core rings, the period of separation from the Loop Current ranges from 5 to 19 months, with the average period of a ring separating every 11 months (Vukovich, 2005). The rings dissipate after a few months to a year (Oey et al., 2005)

Circulation along the Texas/Louisiana shelf varies rapidly throughout the year and is influenced by complex wind and riverine discharge mechanisms. Within the shallower shelf areas less than 30 m (98 ft) deep, currents are wind-driven with a westerly direction for much of the year. A reversal of surface flow occurs in midsummer with the onset of prevailing southerly and southwesterly winds. River plumes from the Mississippi and Atchafalaya produce low-salinity turbid water along the inner shelf of the Louisiana coast, with flows increasing in the spring and weakening during the summer and fall (Walker, 2001).

3.3.2 Water Characteristics

This section provides detailed information regarding the water characteristics of the specific OPAREAs that comprise the AFAST Study Area.

3.3.2.1 Atlantic Ocean, Offshore of the Southeastern United States

The salinity over the continental shelf ranges from 28 to 36 parts per thousand (ppt), with lower salinities found near the coast, and the highest salinities found near the continental shelf break. Salinities are highest in continental shelf waters during winter and lowest in the spring. Variability in this area is due to the intrusion of saltier water (greater than 35 ppt) from the continental slope waters and freshwater input from coastal sources. Continental slope waters in the VACAPES OPAREA maintain a fairly uniform salinity range (32 to 36 ppt) throughout the year, with pockets of high-salinity water (38 ppt) near the Gulf Stream in the fall. Below 300 m (984 ft), the vertical distribution of salinity does not appear to vary, remaining fairly consistent at 34 ppt to approximately 1,000 m (3,280 ft).

There are distinct differences in temperature stratification between summer and winter in the waters of the VACAPES OPAREA. In the winter, the water column is vertically well-mixed, with average water temperatures of 14^{o}C (57^{o}F) at the surface and 11^{o}C (52^{o}F) at depth. The water column in August is vertically stratified, with 25^{o}C (77^{o}F) water near the surface and 10^{o}C (50^{o}F) water at depths greater than 200 m (656 ft).

Summer temperature profiles indicate strong stratification. Surface temperatures average 25^{o}C (77^{o}F) while temperatures at a depth of 200 m (650 ft) average 12^{o}C (54^{o}F). Winter profiles are more constant, averaging 50^{o}F (10^{o}C) throughout the inshore water column and about 23^{o}C (73^{o}F) throughout the offshore water column.

The waters of the JAX/CHASN OPAREA follow an annual temperature cycle. Temperatures in the JAX/CHASN OPAREA vary between 19º and 29ºC (70º and 90ºF). The JAX/CHASN OPAREA has the greatest deviation in temperature in winter, with temperatures varying between 19º and 24ºC (70º and 80ºF). The cooler water temperatures occur along the coast from Charleston, South Carolina, northward. The most stable temperatures occur during summer, with water temperature throughout the JAX/CHASN OPAREA at 27º to 28ºC (81º to 82ºF), with some intrusion of warmer water, about 29ºC (84ºF), around the Gulf Stream.

3.3.2.2 Atlantic Ocean, Offshore of the Northeastern United States

The waters of the Study Area undergo an annual cycle of temperature change. The region from the MAB to the Grand Banks exhibits the highest interannual variability in sea surface temperature (SST) anywhere in the North Atlantic Ocean. There is more than a 20°C (68°F) temperature flux throughout the year along the shore. During most of the year, there is a clear north–to-south gradient of increasing temperatures on the sea surface, with temperatures ranging in winter from 8°C (46.4°F) in the northern part of the Study Area to 20°C (68°F) in the south, while in summer the temperature range is slightly smaller, from about 16°C (60.8°F) near the Bay of Fundy to 26°C (78.8°F) in the southernmost part of the Study Area. The fall and spring exhibit intermediate temperature ranges between the winter and summer extremes.

An annual phenomenon particularly important to the MAB is the formation of the "cold pool." This mass of cooler water is found on the continental shelf in summer and stretches from the Gulf of Maine, along the outer edge of Georges Bank, southwest to Cape Hatteras. The cold pool becomes identifiable as thermal stratification begins in spring and persists until early fall when normal seasonal mixing occurs and homogenizes the water column. The cold pool usually exists near the seafloor between the 40- and 100-m (131- and 328-ft) isobaths and extends up into the water column for about 35 m (115 ft) to the bottom of the seasonal thermocline. The cold pool usually represents about 30 percent of the volume of shelf water. Minimum temperatures for the cold pool occur in early spring and summer and range from 1.1º to 4.7ºC (34.0º to 40.5°F).

During the summer, when the water column is stratified, surface salinities generally increase from shore to the shelf break and from north to south in the Study Area. Average surface salinities range from 32 to 34 practical salinity units (psu) throughout much of the Study Area. Bottom salinities typically only vary by 3 psu.

There is a pronounced salinity minimum (32 psu) on the southern flank of Georges Bank, located throughout the water column over the 60- to 70-m (197- to 230-ft) isobath, and which is associated with 7°C (44.6°F) water. On the north flank and northeast peak, low-salinity water is confined to the near surface over the shelf break. The disparity of these two features suggests that the origin of the freshwater on the south flank was from a Scotian Shelf Water crossover event onto the southern northeast peak.

3.3.2.3 Eastern Gulf of Mexico

Generally, the salinity of the surface water of the GOMEX ranges between 36.0 and 36.3 ppt, whereas the average salinity of ocean water is about 35 ppt. Along the northern continental shelf of the GOMEX, particularly within the outflow of the Mississippi-Atchafalaya Basin, salinity values can drop below 35.0 ppt. The Mississippi River provides a large amount of freshwater to the GOMEX. Near the surface area of the Mississippi River, salinity levels can drop to 25 ppt (Thurman, 1994). Runoff from the Mississippi River decreases salinity to depths of 50 m (164 ft) and to a distance of 150 km (81 NM; 93 mi) from the northern Gulf Coast (Thurman, 1994).

Due to the cycles of freshwater input from local precipitation and river discharge, surface salinities along the northern continental shelf exhibit seasonal variations. River discharges into the GOMEX are highest from March through May and lowest from August through October (Davies et al., 2000). Deep gulf water penetrates onto the shelf during fall and winter when freshwater inputs are low; this increases salinities near the coast. During the spring, increased freshwater inputs establish strong horizontal salinity gradients and decrease inner-shelf salinities.

Seasonal temperature changes in the GOMEX extend to depths between 90 and 125 m (295 and 410 ft), with surface water characteristics identifiable down to the shallower end of this range during winter and down to the deeper end of the range during summer (Thurman, 1994). In the eastern gulf, the thermocline depth—the depth at which the temperature gradient is at maximum—is between about 30 and 60 m (98 and 197 ft) (MMS, 2001). In May, the thermocline depth is approximately 50 m (164 ft).

3.3.2.4 Western Gulf of Mexico

Waters offshore of the western GOMEX are similar in composition and physical characteristic to eastern GOMEX waters. Generally, offshore waters in the western GOMEX are considered pristine in comparison to inshore waters, though natural hydrocarbon seeps do account for concentrations of volatile organic carbons found in some deep-water areas. Western GOMEX waters are characterized by high salinities of 36.0 to 36.5 psu and sea surface temperatures of 29º to 30ºC (84.2º to 86ºF) in August to 14 to 15ºC (57.2 to 59ºF) in January for shallow inshore waters. Thermocline depths, where temperature gradients are at a maximum and vertical transfer of nutrients and energy is restricted, reach 91 to 107 m (299 to 351 ft) in the western GOMEX in January. Dissolved oxygen is highest at the water surface due to photosynthesis and atmospheric exchange. Dissolved oxygen decreases with depth. A region of extremely low dissolved oxygen, or hypoxia, occurs in the summer in the Mississippi River Delta as a result of a layer freshwater and nutrients preventing mixing of the water column. Nutrient levels are typically lower in upper water surface layers where they are taken up by microorganisms and decrease with depth, but the reverse occurs in the hypoxic waters of the Mississippi River Delta (MMS, 2003a).

3.3.3 Bathymetry

Bathymetry is also referred to as seafloor topography. The AFAST Study Area is composed of two regions: the East Coast and the GOMEX. The differences in bathymetry and geology in these regions directly affects the circulation of shelf waters (Ji, 2003). This section provides detailed information regarding the marine geology of the specific OPAREAs comprising the AFAST Study Area.

3.3.3.1 Atlantic Ocean, Offshore of the Southeastern United States

The VACAPES OPAREA includes the nearshore area from just off the mouth of Delaware Bay south to Cape Hatteras and extends seaward into waters more than 4,000 m (13,120 ft) deep. Along the Atlantic coast, the continental shelf extends from the shoreline to a depth of about 200 m (656 ft). At the shelf edge, the shelf gives way abruptly to the continental slope. The continental slope extends to water depths of between 2,000 and 4,000 m (6,560 and 13,120 ft). The continental slope is the most prominent physiographic feature along the mid-Atlantic continental margin and is interlaced with numerous submarine canyons. Four submarine canyons—Norfolk, Washington, Accomac, and Baltimore—are found within the VACAPES OPAREA.

The CHPT OPAREA is located in the nearshore and offshore waters off North Carolina. Like the JAX/CHASN OPAREA, the CHPT OPAREA is located in the SAB. The northern terminus of the Blake Plateau is located on the sea floor of the CHPT OPAREA. The Hatteras Canyon located in the northern part of the CHPT OPAREA is the most southerly canyon found along the continental margin of the East Coast. Other prominent physiographic features are the large sand shoals extending from the barrier island capes off southern North Carolina. Water depths near these shoals are among the shallowest in the OPAREA. Seaward of Cape Hatteras and the

Hatteras Canyon, the ocean bottom deepens rapidly, reaching the maximum water depth in the OPAREA of 4,000 m (13,120 ft).

In the JAX/CHASN OPAREA, water depths within the OPAREA vary from less than 20 m (66 ft) to over 2,700 m (8,860 ft). The greater depths occur primarily along the easternmost boundary of the OPAREA.

Several physiographic features dominate the bathymetry within the JAX/CHASN OPAREA: the continental shelf, the continental slope, and the Blake Plateau. The continental shelf is a gently sloping plain from the coast to approximately the 50-m (164-ft) isobath, at which point it drops sharply to the 200-m (656-ft) isobath. The continental slope within the JAX/CHASN OPAREA is steeply angled and extends approximately from the 200 m (656 ft) to the 700-m (2,300-ft) isobath. The slope is widest at 30ºN (Jacksonville) where it has little topographical variation. The surface of the slope from 30ºN to 32ºN is covered with small hills that have been identified as coral mounds.

The Blake Plateau dominates much of the bottom surface within the JAX/CHASN OPAREA. The plateau is a massive physiographic feature that measures 228,000 square kilometers (km^2) (71,250 square nautical miles [NM^2]) in size. Water depths over the plateau vary between 700 and 1,000 m (2,300 and 3,280 ft). The plateau forms an intermediate bottom surface between the continental shelf to the west, the Bahamas Banks to the south, and the abyssal plain to the east. The Gulf Stream flows along the Florida-Hatteras Slope over the Blake Plateau's western flank.

3.3.3.2 Atlantic Ocean, Offshore of the Northeastern United States

The OPAREAs offshore of the northeastern United States are composed of a large continental sea, the Gulf of Maine; a shoreline fringed with islands; the huge shoal of Georges Bank; numerous basins that are flanked by two deep channels leading to the Atlantic Ocean; more than 70 submarine canyons incising the continental slope; and a chain of seamounts. Water depths in the Study Area range from less than 10 m (32.8 ft) along the inner continental shelf to the abyssal plain, where the maximum water depth is greater than 5,000 m (16,404.2 ft).

Along the eastern United States, the continental shelf ranges in width from less than 2.7 NM (5 km) off southern Florida to nearly 400 km (216 NM) in the Gulf of Maine. The continental shelf has a seaward gradient of less then 1:1,000. The continental shelf from Florida to Martha's Vineyard is a nearly uniform, smooth seafloor with a continental shelf edge that is an evenly curving line marked by multiple canyon heads. The continental shelf of the MAB and southern New England slopes gently offshore and is relatively shallow. Much of the Atlantic City OPAREA and nearly half of the Narragansett Bay OPAREA are located over the continental shelf, in waters greater than 150 m (greater than 492 ft) deep. The continental shelf north of Martha's Vineyard encompasses Georges Bank and the Gulf of Maine and is marked by considerable relief due to glaciation.

Georges Bank is a large (42,000 km^2 or 12,230 NM^2) topographic high or shoal that rises more than 100 m (328 ft) from the seafloor. It is one of the western-most in a chain of banks beginning in the east with the Grand Banks off Newfoundland and ending at Nantucket Shoals to the west of Georges Bank. It is bounded on the north by the Gulf of Maine, to the west and northeast by two channels (the Northeast and Great South channels), and to the south by the continental slope and the Atlantic Ocean. The southern half of Georges Bank is a smooth plain overlain by waters approximately 100 m (328 ft) deep, while the northern part of the bank has much more relief, including a series of shoals, and is shallower (less than 40 m [131 ft]).

The Gulf of Maine is a semi-enclosed continental sea with an area of 90,700 km^2 (26,410 NM^2) and average water depth of 150 m (492 ft). The Gulf of Maine is bounded on the north and west by continental New England, to the northeast by the Bay of Fundy, to the east by Nova Scotia and the Northeast Channel, and to the south by Georges Bank and the Great South Channel. The seafloor of the Gulf of Maine is irregular, with complex bathymetry where water depths range from 9 m (30 ft) (Cashes Ledge) to 377 m (1,237 ft) (Georges Basin).

The continental shelf break is marked by an abrupt increase in the seafloor gradient (from 1:1,000 to 1:10) and ranges in water depth from 100 to 150 m (328 to 492 ft) in the Study Area. With gradients ranging from 1:40 to 1:6, the continental slope extends to water depths of approximately 2,400 m (7,874 ft) in the Study Area. The average width of the continental slope from Georges Bank to Cape Hatteras varies in size from 10 to 50 km (5.4 to 27 NM). The continental slope of the Study Area is incised with more than 70 submarine canyons, the largest being the Hudson Canyon, which also carves into the continental shelf and is the best-developed canyon on the U.S. Atlantic continental margin. A chain of seamounts, or extinct/relict volcanoes, begin on the continental rise off southern Georges Bank and extend 2,576 km (1,390 NM) across the northwestern Atlantic to just northeast of Bermuda.

3.3.3.3 Eastern Gulf of Mexico

The principal physiographic regions of the GOMEX are the continental shelf, the continental slope and associated canyons and escarpments, the continental rise, the abyssal plain, and the Florida and Yucatan straits. A broad continental shelf surrounds much of the margins of the gulf. The continental shelf's width in the northeastern GOMEX ranges from 16 km (9 NM) off the Mississippi River to 350 km (189 NM) along the southern reaches of the west Florida shelf, one of the broadest shelves in the contiguous United States. The continental shelf has a gentle, seaward slope of less than 1 degree to the shelf edge at approximately 200 m (656 ft) water depth.

In the eastern GOMEX, the continental slope extends basinward from the shelf edge to the Florida escarpment at a water depth of approximately 2,000 to 3,000 m (6,560 to 9,840 ft). The overall gradient of the slope is 3 to 6 degrees, with gradients exceeding 20 degrees in some locations, particularly along escarpments.

3.3.3.4 Western Gulf of Mexico

Physiographic regions for the western GOMEX are the same as previously described for the eastern GOMEX. Compared to the eastern GOMEX, the continental shelf is narrow along the Mississippi River Delta region but broadens offshore of Louisiana and Texas to form the Texas-Louisiana shelf. The continental shelf edge is interspersed with salt domes, some of which reach to within 31 m (100 ft) of the surface to form the Flower Garden Banks. The Flower Garden

Banks are two areas of upwardly migrating salt from the ocean bedrock that are capped with coral reefs (Deslarzes, 1998).

3.3.4 Bottom Types

Overall, the bottom types found in the AFAST Study Area consist of sediments that are terrestrial (i.e., relating to land) in origin. With respect to geophysical features, the continental shelf, continental slope, continental rise, and the abyssal plain are features common to all active sonar activity areas located along the East Coast and in the GOMEX. The continental shelf extends from the shoreline to the shelf break or shelf edge. At the shelf break, there is usually a marked increase in slope where the continental shelf joins the steeper continental slope. The continental rise is a zone approximately 100 to 956 km (54 to 516 NM) wide at the base of the continental slope, marked by a gentle seaward gradient ending in the abyssal plain. Submarine canyons and deep-sea channels are found in the continental slope and rise. Submarine canyons are steep, V-shaped canyons cutting through the continental slope, continental rise, and, less commonly, the continental shelf. This section provides detailed information regarding the sediments of the specific OPAREAs comprising the AFAST Study Area.

3.3.4.1 Atlantic Ocean, Offshore of the Southeastern United States

The VACAPES OPAREA is located in the MAB oceanic province. The continental shelf and continental slope of the MAB are covered with unconsolidated sediments, primarily sand, silt, clay, and some gravel. The bottom sediments north of Cape Hatteras contain very little carbonate.

Although sand dominates the sediments of the continental shelf in the CHPT OPAREA, the concentration of sand typically declines with increasing water depth down the continental slope and rise, where clay and silt predominate. The sandy southern North Carolina continental slope is somewhat atypical, but north of Cape Hatteras, silt and clay regain their dominance in continental slope sediments. Lime outcrops covered with live, deep-water corals occur in scattered locations in Onslow Bay.

The substrate composition within the JAX/CHASN OPAREA varies from mixed fine sand and gravel near the coast to an increasingly higher percentage of calcium carbonate material at greater depths. Periodically, small inclusions of gravelly sand, sand and clay, and fine-grained sand and silt are found in deeper waters. Most sands on the continental shelf are remnants of delta and riverine deposits. Continental slope sediments in the south Atlantic area are primarily composed of silt and clay.

3.3.4.2 Atlantic Ocean, Offshore of the Northeastern United States

The substrate underlying the northeast is composed almost entirely of clastic soft sediments that are terrestrial in origin. Clastic sediments are typically derived from sandstone and shale. The majority of sediments now found on the continental shelf are the result of glacial deposition, erosion, reworking, and re-deposition. The sands found on Georges Bank, and the remainder of the northeastern continental shelf, are quartz-rich. Sediments in the northeast contain little carbonate (less than 5 percent).

There is a unique sediment feature on the continental shelf, just south of Nantucket Shoals, known as the Mud Patch. This large deposit of fine-grained sand-clay and silt is the only area on the outer continental shelf of the eastern United States where surface sediments contain more than 30 percent silt and clay. Sediments on the continental slope and rise are fine-grained, consisting primarily of silty clays or clayey silts.

3.3.4.3 Eastern Gulf of Mexico

Overall, the sediments found in the GOMEX largely are clastic and are derived from terrestrial sources, of which the most common types are sandstone and shale.

3.3.4.4 Western Gulf of Mexico

Overall, the sediments found in the GOMEX largely are clastic and are derived from terrestrial sources, of which the most common types are sandstone and shale.

3.4 MARINE HABITAT

The environment that supports all sea life is considered the marine habitat. Marine habitat is characterized by several factors. Sediment and water quality are two factors that can be affected by various contaminates that enter a marine habitat through pollution. This section will discuss the general condition of the marine habitat within the Study Area.

3.4.1 Contaminated Sediment

Sediment contamination is a topic that has become increasingly important over the years. For instance, the U.S. banned the manufacture and distribution of polychlorinated biphenyls (PCBs) and dichlorodiphenyltrichloroethane (DDT) in the 1970s; however, historical deposits of these two halogenated hydrocarbons continue to be an active source of contamination in coastal watersheds and sediments. Moreover, the presence of mercury in sediments has become of increasing concern, as human health risk assessments have shown that consumption of certain fish species in contaminated areas causes an elevated risk of cancer. Mercury can be released into the environment through a variety of processes such as industrial releases, abandoned mines, fossil fuel burning for electric power, and the weathering of rock (Coasts and Oceans, 2002).

According to the United States Environmental Protection Agency (EPA), contaminated sediments are defined as soils, sand, organic matter, or minerals that accumulate on the bottom of a water body and contain toxic or hazardous materials that may adversely affect human health or the environment (EPA, 1998b). Contaminants most often found in sediments are broken into five major groups as follows:

1. Bulk organics from sewage treatment plants, oil and grease, and other organic wastes.
2. Halogenated hydrocarbons, such as DDT and PCBs.
3. Polycyclic aromatic hydrocarbons (PAHs), usually associated with crude oil, fossil fuel burning, municipal and industrial effluents, and river discharges.

4. Heavy metals, such as iron, zinc, copper, lead, and mercury, as well as metalloids including arsenic and selenium typically from consumer products, such as batteries, medical applications, electronics, and chemical industries. Heavy metal enrichment increases with decreasing sediment particle size.
5. Nutrients, through unwanted algal growth, oxygen depletion in overlying waters, and altered food chains or species succession (Hameedi et al., 2002).

Possible sources of contamination may originate from a variety of activities including, but not limited to, maritime commerce, continental run-off, and dredging (Hameedi et al., 2002; GEOTRACES, 2006). Approximately 20 percent of the dredged sediments are disposed of in the ocean (EPA, 2007b). Approximately 10 percent of the dredged sediments are heavily contaminated from a variety of sources including shipping, industrial and municipal discharges, and land runoff. Typical contaminants include heavy metals, such as cadmium, mercury and chromium; hydrocarbons, such as oil; organochlorines such as pesticides; and nutrients such as nitrogen and phosphorous. As such, disposal of these materials carries the possibility of acute or chronic toxic effects on marine organisms, and potential contamination of human food sources (United Nations, 2007).

The U.S. Army Corps of Engineers (ACE) spends more than $1 billion annually dredging and maintaining the 154 coastal inlets under its responsibility (ACE, 2007a). In 2006, the ACE awarded 131 contracts worth over $491 million to dredge more than 113 million cubic yards of sediment (ACE, 2007b).

In 1972, Congress enacted the Marine Protection, Research, and Sanctuaries Act (MPRSA, also called the Ocean Dumping Act), which prohibits dumping material into the ocean that would unreasonably degrade or endanger human health or the marine environment. Prior to final disposition into the ocean, a permit must be issued by the USACE, which is subject to EPA's approval. In addition, the materials must be tested to determine compliance with EPA's environmental criteria for ocean dumping. These criteria consider the potential environmental impact associated with the disposal, the need for disposal in the ocean, the potential effects to aesthetic, recreation, and economic values, and the adverse effects of the disposal on other uses of the ocean. A permit is not issued if there is insufficient information available to ensure that disposal of sediment into the ocean would not cause significant harmful effects to the ocean or environment (EPA, 2007b).

Currently, no studies documenting the effects of dredge-spoil dumping on deep-sea communities have been found. Determining the sources of sediment contaminants could be a difficult task for a variety of reasons. For example, within the sediment matrix alone, contaminants could be re-suspended, transported, and re-deposited to an area located further from the original source. In addition, it is possible that contaminants may be desorbed, or released back into the water column. This action would then make the sediments a source, as well as a sink (a process that acts to remove a substance) (Hameedi et al., 2002). Desorption can occur in mixing zones; for example, where a river empties into the ocean. Even though some portion of the contaminants will remain in estuarine sediments, the remainder could potentially be transported to the ocean, perhaps in an entirely different form than what existed in the freshwater system (GEOTRACES, 2006).

Even though the sources of contamination may be difficult to determine, it is still important to know the possible effects of these contaminants, as they are presently in the environment. Polluted sediments can be a foundation of contamination throughout the food chain, which could potentially damage the marine habitat. For instance, bottom-feeding organisms incorporate the contaminants into their bodies. Once ingested by larger organisms, the contamination moves up through the food chain, resulting in bioaccumulation. When this occurs, effects could be observed at all levels of the biological organization, from the molecular to the ecosystem level (Fent, 2002). One example is the widespread contamination of harbor sediments due to the on-going use of organotins (chemical compounds containing tin) in antifouling paints, which aids to prevent the accumulation of deposits on the bottom of large ships. These chemicals accumulate in the sediments and remobilize during dredging activities, which could contaminate other sediments (Fent, 2002). There are several studies on the ecotoxicity of organotins; however, the long-term effects on the structure and function of aquatic systems is not fully understood (Fent, 2002). This may be due to the fact that effects may only manifest themselves after biochemical dysfunction, physiological abnormalities, growth impairment, and ecologically important changes have already occurred; thus, making it difficult to distinguish between natural and anthropogenic causes (Hameedi, et al., 2002).

3.4.2 Marine Debris

Debris is defined as solid materials that enter oceans and coastal waters; these materials are often referred to as litter. Common types of debris include plastic bags, bottles and cans, cigarette filters, bottle caps, and galley waste (EPA, 2005). Since World War II, the U.S. has taken steps to limit and reduce ocean dumping, and beginning in 1972, several national and international regulations have been introduced to reduce this practice. Currently, with the exception of dredged material, the only materials permitted to be dumped in the ocean are fish wastes, human remains, and vessels. However, as will be discussed, marine debris finds its way into the ocean a number of ways.

The majority of ocean dumping in the Atlantic Ocean is along the coastlines. As stated previously, 20 percent of the dredged sediments are disposed of in the ocean (EPA, 2007b). Dredging operations are mostly associated with keeping waterways from filling up with sediment. These dredging activities comprise approximately 80 to 90 percent of the material dumped at sea, which amounts to hundreds of millions of tons per year (United Nations, 2007). Other dredging operations are associated with new works. However, future dredging operations and ocean disposal requirements are expected to follow current trends (United Nations, 2007).

Known low-level radioactive waste was dumped in the ocean in the North Atlantic Ocean near the mid-Atlantic Ridge, but this practice was discontinued in 1972. In addition, prior to 2002, commercial passenger ships and cruise liners routinely dumped solid and liquid waste into the ocean. However, this type of ocean dumping occurred in the transit lanes along coastlines, and not in the open ocean. It is now illegal for ships to conduct this practice and it no longer occurs.

Another common source of pollution through ocean dumping is abandoned, lost, and ruined fishing gear. During the 1950s, most of the world’s fishing industries largely replaced nets and gear made of natural fibers such as cotton, jute, and hemp with those made of synthetic materials, such as nylon, polyethylene, and polypropylene. The problem with these materials is that unlike natural fiber gear that degrades over time, synthetic fishing gear is functionally resistant to degradation in the water. Hence, once discarded or lost, this gear remains in the marine environment, with potential negative economic and environmental effects. For example, in 2002, NOAA collected 107 metric tons (118 tons) of nets and lines and other fishing gear on the Pearl and Hermes Atoll (northern Hawaiian Islands) alone (Adler and Jeftic, 2006). In 2003, another 90 metric tons (99 tons) were found near the Pearl and Hermes, and Midway Islands (Adler and Jeftic, 2006).

In addition to fishing gear, land-based sources can account for up to 80 percent of the world's marine pollution (Sheavly, 2007). This debris is the result of recreational beach activities, water-based activities (recreational, military, and commercial), undersea exploration and resource extraction of oil and gas, and debris entering the ocean via wind or water run-off (Sheavly, 2007). Several factors, including, but not limited to ocean current patterns, climate, tides, industrials and recreational areas, shipping lanes, and fishing grounds influence whether debris is found in the open ocean or coastal area (Sheavly, 2007).

Ocean Conservancy, along with the Marine Debris Monitoring Workgroup, developed the National Marine Debris Monitoring Program to standardize marine debris data collection in the U.S. A five-year study was conducted from September 2001 to September 2006 (Sheavly, 2007). For the study, the U.S. coastline was divided into nine regions based on prevailing ocean currents and logistical considerations of access. Debris found was classified as land-based, general, or ocean-based. Land-based debris included items such as syringes, motor oil containers, balloons, straws, and six-pack rings. General debris included plastic bags, strapping bands, and various plastic bottles. Ocean-based debris included items such as gloves, plastic sheets, light bulbs/tubes, nets, traps/pots, fishing line, rope, salt bags, fish baskets, cruise line logo items, and floats/buoys (Sheavly, 2007). The results of the study indicated total debris (land-based, ocean-based and general source debris combined) increased during the five-year study along the East Coast (specifically north of Cape Cod to the U.S./Canada border) while ocean-based debris decreased south of Cape Cod (Sheavly, 2007). The majority of debris discovered north of Cape Cod was ocean-based debris items, comprising 42 percent. However, ocean-based debris items only comprised 6.9 percent of debris discovered south of Cape Cod to North Carolina and 14.3 percent from North Carolina to Florida (Sheavly, 2007). Further, an increase in the amount of general-source debris in the GOMEX was reported, while ocean-based debris comprised 15.9 percent (Sheavly, 2007). Overall, ocean-based debris items comprised 17.7 percent of all debris discovered during the study (Sheavly, 2007).

During the 2005 International Coastal Cleanup Campaign event, over 170,000 volunteers in the United States picked up more than 3.2 million items, with a total weight of more than 1.7 million kg (3.8 million lb). Overall, 56 percent of the marine debris found in the U.S. originated from land-based activities (Ocean Conservancy, 2005). The greatest amount of expended materials was retrieved from California (12.7 percent), Georgia (11.4 percent), North Carolina (8.8 percent), Florida (8.7 percent), Virginia (5.5 percent), and Texas (5.5 percent) (Ocean Conservancy, 2005b). Debris retrieved from ocean and waterway activities originating offshore accounted for 6 percent of the materials found in the U.S. (Ocean Conservancy, 2005b). Additionally, U.S. volunteers discovered 88 animals entangled in expended materials. Expended fishing line was responsible for nearly half of all entanglements, followed closely by rope and fishing nets (Ocean Conservancy, 2005a). This 2005 report did not show any military items recovered.

3.4.3 Water Quality

There is very little information on open ocean water quality, and research on this topic remains ongoing. However, poor water quality may affect the health of marine species by reducing the quantity and diversity of prey species (NOAA, 2006). Chemical pollutants may have an affect through ingestion and long-term accumulation in the body. Specifically, pollutants have a tendency to bioaccumulate based on where the animal is situated within the food chain. For example, chemical pollutant levels in mysticetes are generally several orders of magnitude lower than the levels found in seals or odontocetes (toothed cetaceans) because seals and odontocetes feed on fish higher up in the food chain, whereas mysticetes feed on zooplankton, which are located near the bottom of the food chain (NOAA, 2006).

The deposition of contaminants and other anthropogenic materials from the atmosphere is an important mode of transport; however, this mode is poorly understood and not easily quantified. It is known that the transport and dispersion of air pollutants into the marine environment are influenced by many factors, including global and regional weather patterns (NOAA, 2006). At the local level, wind speed and direction, vertical air temperature gradients, air-water temperature difference, and the amount of solar heating are primary factors affecting transport and dispersion of air pollutants out to sea. As there are many factors that determine where air pollutants are transported and how well they are diluted, it is difficult to estimate the amount of pollutants from shipping vessels at sea that are transported to land and those pollutants that are taken up by the ocean without a complex model (NOAA, 2006).

Contaminants found in the coastal environment include suspended solids, organic debris, metals, synthetic organic compounds, nutrients, and pathogens. Chemical pollutants from oil spills, leaks, discharges, and organotins may also enter the water during shipping operations (NOAA, 2006). These substances may flow outward to sea and eventually impact water quality in the open ocean. Pollutants also are generated by vessels on the open ocean, but discharges are regulated in state and Federal waters out to the Contiguous Zone. However, it has been noted that space on most fishing vessels is too limited to allow waste oil storage tanks or a waste oil-water separator to comply with international maritime regulations (Lin, et al, 2007).

Discharges may contain food waste, oil and grease, cleaning products, detergents, oil, lubricants, fuel, and sewage. Discharges of untreated sewage in unregulated waters may cause eutrophication, or an influx of high levels of nutrients. This in turn leads to excessive plant growth, which takes more oxygen from the water. The limiting availability of oxygen, in extreme cases, can harm or kill other organisms in the water (NOAA, 2006). The following contaminants are of particular concern with regard to marine species (NOAA, 2006):

- Persistent organic pollutants such as PCBs, Polychlorinated dibenzodioxins (PCDDs), polychlorinated dibenzofurans (PCDFs), polycyclic aromatic hydrocarbons (PAHs), DDT, chlordanes, halogenated cyclic hydrocarbons (HCHS), and other pesticides.
- Flame retardants: polybrominated diphenyl ethers (PBDEs) and other brominated flame retardants.

- Plasticizers: Phthalate esters.
- Surfactants: Alkyphenol ethoxylates (e.g., nonylphenoletoxylates [NPEO]).
- New-era pesticides and herbicides.
- Municipal and industrial effluents: Endocrine disrupting compounds (e.g., synthetic estrogens, natural hormones, pulp byproducts).
- Anti-fouling agents: Organotins and replacement compounds.
- Dielectric fluids: PCB replacements (e.g., polychlorinated napthalenes [PCNs] and polybrominated biphenyls [PBBs]).
- Aquaculture related chemicals such as antibiotics and pesticides.
- Metals such as methyl mercury (MeHg).

Concentrations of organochlorines; including DDT, PCBs, HCHs, aldrin, and dieldrin have been observed in many species of marine mammals (NOAA, 2006). PCBs have also been found in samples of North Atlantic right whale blubber and, at low levels, in zooplankton sampled from Cape Cod Bay. PCBs, DDT, and other organochlorines have been detected in North Atlantic right whale samples from the Bay of Fundy, Browns, and Baccarro Banks (NOAA, 2006). Although levels of contaminants have been detected in marine mammals, it is unknown whether the levels found are sufficiently high to be detrimental to the species.

Another source of water pollutants that may have an effect on the health of the marine habitat is biotoxins. Biotoxins are highly toxic compounds produced by harmful algal blooms. Several classes of biotoxins have been implicated in marine mammal mortality events, can be found in right whale habitat, and have been known to cause a loss of equilibrium and respiratory distress and to have feeding implications (NOAA, 2006).

It is difficult to gauge the general water quality within the Study Area. Liu et al. (2007) conducted a study of deep ocean water quality off the coast of Taiwan. As part of the study, over 60 different water quality parameters (such as heavy metals, herbicides, chlorinated compounds, dioxins, and trace elements) were collected from varying water depths at six different sites. (The study area depths ranged from 20 to 750 m [66 to 2,461 ft].) Results indicated that sunlight is most often absorbed in the upper portion of coastal waters, and can penetrate over 100 m (328 ft) in clear ocean waters. However, sunlight cannot reach the deep oceanic waters. As such, waters in this region were found to have lower temperatures (i.e., up to a 20°C [68°F] difference), are richer in nutrients, and have fewer (if any) suspended particles and pathogens in comparison the surface of the ocean (Liu et al., 2007). It can be inferred through the results of this study that the water quality is directly proportional to the depth.

3.4.4 U.S. Military Activities

3.4.4.1 Debris

The Act to Prevent Pollution from Ships (APPS) requires U.S. public vessels, including warships, to comply with International Convention for the Prevention of Pollution from Ships (MARPOL) Annex V discharge requirements, including the plastic discharge prohibition and special area limitations. Submarines must comply with MARPOL Annex V discharge requirements, including the plastic discharge prohibition and the special area discharge requirements after December 31, 2008. However, APPS permits U.S. Navy ships to discharge in MARPOL Annex V special areas in the following manner:

- Ships and submarines may discharge a slurry of seawater, paper, cardboard or food waste capable of passing through a screen with openings no larger than 12 millimeters in diameter outside 5.6 km (3 NM) from land.
- Surface ships may discharge metal and glass that have been shredded and bagged to ensure negative buoyancy outside 22.2 km (12 NM) from land.
- As of December 31, 2008, submarines may discharge non-plastic garbage that has been compacted and weighted to ensure negative buoyancy outside 22.2 km (12 NM) from land.

All Navy vessels are required to minimize the volume of plastic material taken to sea that could become waste while at sea. Specifically, the Navy minimizes the amount of plastic supplies used aboard ship, replaces plastic disposable items with non-plastic items where possible, and, if appropriate, removes plastic wrapping and shipping materials from supply items before bringing them on board.

If the plastic waste storage capacity of the ship is exhausted and operational considerations require, then as a last resort, plastic overboard discharge is authorized. Such discharges may only be made beyond 93 km (50 NM) from the nearest land, and the amount discharged must be minimized under these circumstances. In addition, Navy ships shall make such discharges in weighted bags to ensure negative buoyancy and record the details of such a discharge (date, time, and location of discharge, approximate weight and cubic volume of the discharge, and nature of the material discharged) in the Ship's Deck Log and report the commencement of plastics discharges to the appropriate operational commander.

3.4.4.2 Expended Materials Used for Training

Various types of small, expendable training items are shot, thrown, dropped, or placed within the training areas. These items include smoke grenades, flares, and sonobuoys of various types. They are used in relatively small quantities for selected training activities, and are scattered over a large area. Items that are expended on the water, and fragments that are not recognizable as training debris (e.g., flare residue, or candle mix), are not collected. Sonobuoys and debris from flares, smoke grenades, and other pyrotechnic devices that fall in the water may release small amounts of toxic substances as they degrade and decompose. The items degrade very slowly, so the volume of decomposing training debris within the training areas, and the amounts of toxic substances being released to the environment, gradually increases over the period of military use. Concentrations of some substances in sediments surrounding the disposed items would increase over time. Sediment movements in response to tidal surge and longshore currents, and sediment disturbance from ship traffic and other sources, would eventually disperse contaminants outside of the training areas.

Surface targets are used during Missile and Bombing Exercises. Surface targets are stripped of unnecessary hazardous constituents, and made environmentally clean; therefore, only minimal amounts of hazardous constituents are onboard.

Each Sinking Exercise (SINKEX) uses as a target an excess vessel hulk that is eventually sunk during the course of the exercise. The target is an empty, cleaned, and environmentally remediated target vessel that is towed to a designated location where various ships, submarines, or aircraft use multiple types of weapons to fire shots at the target vessel. The EPA granted the DON a general permit through the Marine Protection, Research, and Sanctuaries Act to transport vessels “for the purpose of sinking such vessels in ocean waters…” (40 Code of Federal Regulations [CFR] Part 229.2). Subparagraph (a)(3) of this regulation states “all such vessel sinkings shall be conducted in water at least 1,829 m (6,000 ft) deep and at least 93 km (50 NM) from land.” According to Naval Sea Systems Command (NAVSEA), the Navy has conducted an average of 10 sink exercises per year since 1997 (NAVSEA, 2007).

The plastic retention requirements apply only to disposal of plastic waste. These requirements do not apply to normal use of expendable military equipment that contains plastic, such as targets, weather balloons, sonobuoys, etc., because the plastic in these items is not considered "waste" when normal use of the items results in their release into the ocean. However, in keeping with Navy policy to protect the marine environment, expendable items that can be retrieved after use, particularly targets, should be retrieved, if safe and practicable to do so. Once collected after use, plastic components of such items should be regarded and managed as plastic waste.

3.4.4.3 Past Open Ocean Disposal of U.S Military Chemical Munitions

Before the enactment of the Marine Protection, Research, and Sanctuaries Act in 1972, one of the accepted practices for the disposal of chemical weapons by the U.S. military included ocean dumping because it was thought that the vastness of ocean waters would absorb any chemical agents that leaked. The first recorded instance of ocean disposal of chemical weapons was in 1918 at an unknown location in the Atlantic Ocean between the United States and England. The last recorded instance occurred in 1970, approximately 402 km (217 NM) off the coast of Florida (Bearden, 2006). The Department of Defense first publicly acknowledged ocean disposal of chemical weapons by the U.S. military in the late 1960s, but little information about specific disposal locations was provided. In 2001, the Army published more information on this topic than had previously been released. Even so, the Army’s records included exact coordinates for only a few disposal sites. The locations of most disposal sites were indicated by using general references to the sites being offshore from specified states or cities, and sometimes the approximate distance from shore was provided. Eleven sites appear to be in the vicinity of the Atlantic region (U.S. Army, 2001). Chemical agents disposed of in the vicinity of the Atlantic region include arsenic trichloride, lewsite, mustard gas, nerve gas, and white phosphorus.

3.5 SOUND IN THE ENVIRONMENT

This section describes the ambient sound environment comprising physical, biological, and anthropogenic sources. Figure 3-3 illustrates the frequencies of each sound source. Table 3-4 provides example intensities (source level) of various underwater sound producers.

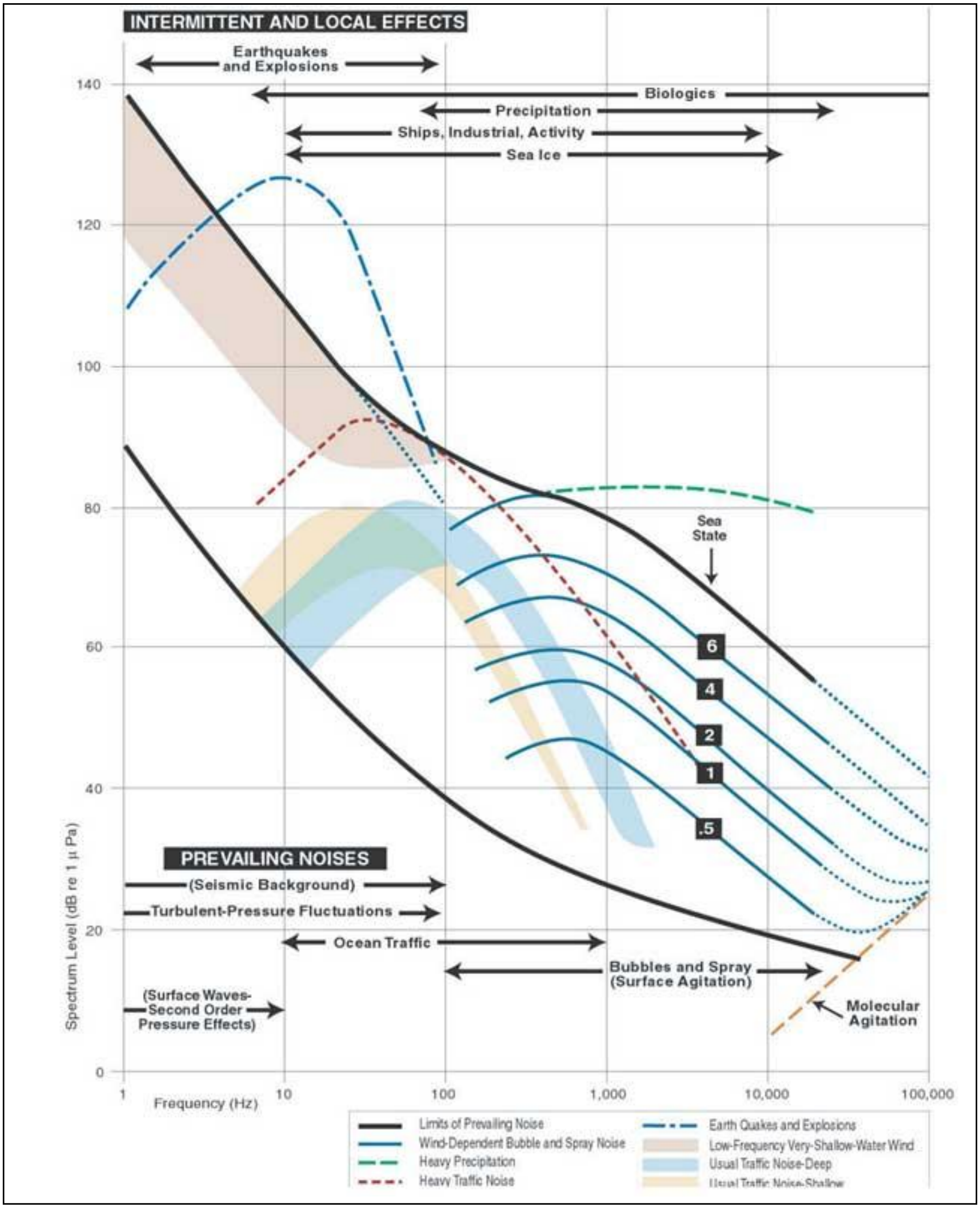


Figure 3-3. Ambient Sound Levels
(adapted from Wenz, 1962)

Table 3-4. Source Levels of Common Underwater Sound Producers

Source	Source Level (decibels referenced to 1 micro Pascal at 1 meter)
Jet ski	75-125
Dolphin whistles	125-173
Humpback whale song	144-174
Blue whale	165
Snapping shrimp	183-189
Supertanker (340 meters long)	190
ATOC Acoustic Thermometry Source	195
Fishing vessel (12 meters long)	150
Earthquake	210
Mid-frequency Naval Sonar	235
Sperm whale click	236
Lightning strike	260

ATOC = Acoustic Thermometry of Ocean Climate

Sources: Scowcroft et al., 2006; Inter-Agency Committee on Marine Science and Technology (IACMST), 2006; NOAA Pacific Marine Environmental Laboratory, 2007; and Simmonds, 2004

3.5.1 Physical Sources of Sound

Physical processes that create sound in the ocean include rain, wind, waves, lightning striking the sea surface, undersea earthquakes, and eruptions from undersea volcanoes (Scowcroft et al., 2006). Generally, these sound sources contribute to a rise in the ambient sound levels on an intermittent basis. Rain produces sound in much the same manner as does wind; however, rain sound differs from wind sound in that its peak contribution to the field occurs at a slightly higher frequency, typically between 1 and 3 kilohertz (kHz). Even at moderate rain rates, the sound generated at these frequencies can easily exceed contributions from wind. For instance, the onset of rain raises high-frequency sound levels by 10 dB or more (U.S. Air Force, 2002).

Wind produces frequencies between 0.1 and 30 kHz, while wave generated sound is a significant contributor in the infrasonic range (i.e., 0.001 to 0.020 kHz) (Simmonds et al., 2004). In addition, seismic activity results in the production of low-frequency sounds that can be heard for great distances (Discovery of Sound in the Sea [DOSITS], 2007). For example, in the Pacific Ocean, sounds from a volcanic eruption have been heard thousands of miles away (DOSITS, 2007).

3.5.2 Biological Sources of Sound

Marine animals use sound to navigate, communicate, locate food, reproduce, and protect themselves underwater (Scowcroft et al., 2006). For example, reproductive activity, including courtship and spawning, accounts for the majority of sounds produced by fish. During the spawning season, croakers vocalize for many hours and often dominate the acoustic environment (Scowcroft et al., 2006). In addition, toothed whales and dolphins (odontocetes) produce a wide variety of sounds including clicks, whistles, and pulsed sounds. Marine life of various types can raise sound levels near 20 dB (e.g., dolphin whistles), in the range of a few kHz (e.g., crustaceans and fish), and in the tens to hundreds of kHz (e.g., dolphin clicks). For instance, bottlenose dolphin clicks and whistles have a dominant frequency range of 110 to 130 kHz and 3.5 to

14.5 kHz, respectively (Au, 1993; Ketten, 1998). In addition, sperm whale clicks range in frequency from 0.1 kHz to 30 kHz, with dominant energy in two bands (2 to 4 kHz and 10 to 16 kHz) (Thomson and Richardson, 1995). Figure 3-3 illustrates the variability from all of these potential sound sources.

3.5.3 Anthropogenic Sources of Sound

Anthropogenic (man-made) sound is introduced into the ocean by a number of sources, including vessel traffic, industrial operations (pile driving), seismic profiling for oil exploration, oil drilling, and sonar operation for scientific research. For in-depth information concerning the acoustic effects and potential effects in marine mammals and fishes, refer to Chapter 4 and 6.

In open oceans, the primary persistent anthropogenic sound source tends to be commercial shipping, since over 90 percent of global trade depends on transport across the seas (Scowcroft et al., 2006). Specifically, there are approximately 20,000 large commercial vessels at sea worldwide at any given time. The large commercial vessels produce relatively loud and predominately low-frequency sounds. Most of these sounds are produced as a result of propeller cavitation (when air spaces created by the motion of propellers collapse) (Southall, 2005). In 2004, NOAA hosted a symposium entitled "Shipping Noise and Marine Mammals." During Session I, Trends in the Shipping Industry and Shipping Noise, statistics were presented that indicate foreign waterborne trade into the United States has increased 2.45 percent each year over a 20 year period (1981 to 2001) (Southall, 2005). International shipping volumes and densities are expected to continually increase in the foreseeable future (Southall, 2005). The increase in shipping volumes and densities will most likely increase overall ambient noise levels in the ocean. However, it is not known whether these increases would have an effect on marine mammals (Southall, 2005).

High intensity, low frequency impulsive sounds are emitted during seismic surveys to determine the structure and composition of the geological formations below the sea bed in order to identify potential hydrocarbon reservoirs (i.e., oil and gas exploration) (Simmonds, 2004). One type of sound source is airguns. These devices rapidly release compressed air with source levels between 215 and 230 dB with a reference pressure of 1 micro Pascal at 1 meter (dB re 1 μPa-m), and the highest energies falling in the range of 0.01 to 0.3 kHz, into the water. Airgun shots are fired at 6 to 20 second (sec) intervals along transect lines at speeds ranging from 2 to 3 m per sec (4 to 6 knots) at a depth of 4 to 10 m (13 to 33 ft) (Simmonds, 2004).

Commercial vessels have the highest sound levels at lower frequencies. Since sound propagation is most favorable at lower frequencies, particularly in deep water, surface ships can often be heard at distances greater than 100 km (54 NM). Thus, at many deep-water locations, it is not unusual for a low-frequency sound to be influenced by contributions from tens or even hundreds of surface ships (U.S. Air Force, 2002).

3.6 MARINE MAMMALS

More than 120 species of marine mammals occur worldwide (Rice, 1998). The term “marine mammal” is purely descriptive and refers to mammals that carry out all or a substantial part of their foraging in marine or, in some cases, freshwater environments. Marine mammals as a group are comprised of various species from three orders (Cetacea, Carnivora, and Sirenia).

Cetaceans are divided into two major suborders: Mysticeti (baleen whales) and Odontoceti (toothed whales). Members of the Odontoceti are generally smaller than Mysticetes and have teeth rather than Mysticetes, which use baleen to filter their prey from the water. In addition to contrasts in feeding methods, there are life history and social organization differences (see Tyack, 1986). Pinnipeds are divided into three families: Phocidae (the “true” or earless seals); Otariidae (sea lions and fur seals); and Odobenidae (walruses). Four living sirenian species are classified into two families: Trichechidae, with three species of manatees, and Dugongidae, the dugong. Sirenians are the only completely herbivorous marine mammals. Of the sirenians, only the West Indian manatee occurs along the U.S. Atlantic coast.

Cetaceans have undergone numerous anatomical and physiological adaptations to the marine environment that are discussed in detail by Pabst et al. (1999). These include significant changes from terrestrial mammalian sensory systems to accommodate the unique challenges that a marine environment imposes. Cetaceans have well-developed senses of touch and sight, with highly innervated skin and an eye structure that allows them to see well in air, as well as in water (Van der Pol et al., 1995; Wartzok and Ketten, 1999). Due to increased density, sound travels farther and faster in water than in air (Urick, 1983). This physical property can allow for more effective communication and echolocation but requires drastic changes in auditory and sound production structures (Wartzok and Ketten, 1999). Marine mammal vocalizations often extend both above and below the range of human hearing. Sound frequencies lower than 18 Hertz are termed infrasonic and those higher than 20 kHz are ultrasonic. Baleen whales generally utilize lower frequencies. Depending upon the species, mysticetes produce tonal sounds between 20 and 3,000 Hz. Clark and Ellison (2004) suggested that baleen whales may use low-frequency sounds not only for long-range communication but also as a simple form of echo-ranging. Echolocation may allow mysticetes to navigate and orient relative to physical features of the ocean. Toothed whales also produce a wide variety of sounds (Wartzok and Ketten, 1999). Species-specific broadband “clicks” with peak energies between 10 and 200 kHz are used for echolocation. Tonal vocalizations (whistles), ranging from 4 to 16 kHz, are important to communication. Individually variable burst-pulse click trains have also been identified. However, not all toothed whales fully utilize this repertoire. Sperm whales only produce clicks, which presumably function in both communication and echolocation (Whitehead, 2003).

Empirical data on cetacean hearing are sparse, particularly for baleen whales. However, auditory thresholds of some smaller odontocetes have been determined. It is generally believed that cetaceans should at least be sensitive to the frequencies of their own vocalizations. Indications of sensitivity ranges at various frequencies have been developed from comparisons of cetacean inner ear anatomy and structural models of ear responses to vibrations. The ears of small toothed whales are specialized for receiving high-frequency sound, while baleen whale inner ears are best suited to low or infrasonic frequencies (Ketten 1992, 1997).

Sounds produced by pinnipeds include airborne and underwater vocalizations (Thomson and Richardson, 1995). Calls include grunts, barks, and growls in addition to the more conventional whistles, clicks, and pulses. The majority of pinniped sounds are in the sonic range (20 Hz to 20 kHz; Ketten, 1998; Wartzok and Ketten, 1999). In general, phocids are far more vocal underwater than are otariids. Phocid calls are commonly between 100 Hz and 15 kHz, with peak spectra less than 5 kHz, but can range as high as 40 kHz (Ketten, 1998; Wartzok and Ketten, 1999). There is no evidence that pinnipeds echolocate (Schusterman et al., 2000).

General reviews of cetacean and pinniped sound production and hearing may be found in Richardson et al. (1995), Edds-Walton (1997), Wartzok and Ketten (1999), Au et al. (2000), and Hildebrand (2005). For a discussion of acoustic concepts, terminology, and measurement procedures, as well as underwater sound propagation, Urick (1983) and Richardson et al. (1995) are recommended.

Cetaceans inhabit most marine environments, from deep ocean canyons to shallow estuarine waters; however, they are not randomly distributed. Cetacean distribution is affected by several factors including demographics, ecological conditions, anthropogenic activities, and prey availability. Species occurring off the continental shelf are often associated with physical features (such as banks, canyons, or the shelf edge) that tend to concentrate prey. Cetacean movements are often related to breeding or feeding activity. Some baleen whale species make extensive annual migrations. Cetacean occurrence and movement have also been linked to indirect prey indicators such as temperature variations, chlorophyll concentration, and water depth. Occurrence may also be related to oceanographic features such as upwelling events or warm-core rings. Areas of upwelling may contain concentrated nutrients, which results in increased primary food source availability. This has a cascading effect on trophic dynamics, and such areas are generally associated with higher-than-average levels of zooplankton, fishes, and cetaceans.

The Marine Mammal Protection Act (MMPA) affords federal protection to all marine mammals, and several are also listed under the Endangered Species Act (ESA). The MMPA defines a stock as "a group of marine mammals of the same species or smaller taxon in a common spatial arrangement that interbreed when mature." For the purposes of management under the MMPA, a stock is therefore recognized as being a management unit that identifies a demographically isolated biological population. In practice, identified stocks may fall short of this ideal because of a lack of information, or other reasons. As shown in Table 3-5, 43 marine mammal species have possible or confirmed occurrence along the East Coast or in the Gulf of Mexico. The species include cetaceans, pinnipeds, and a sirenian.

Table 3-5. Marine Mammals with Possible or Confirmed Occurrence Along the East Coast and in the Gulf of Mexico

Common Name	Scientific Name	ESA Status	Possible Location
Suborder Mysticeti (baleen whales)			
Family Balaenidae (right whales)			
North Atlantic right whale	*Eubalaena glacialis*	Endangered	East Coast
Family Balaenopteridae (rorquals)			
Humpback whale	*Megaptera novaeangliae*	Endangered	East Coast
Minke whale	*Balaenoptera acutorostrata*		East Coast
Bryde's whale	*Balaenoptera edeni*		East Coast and GOMEX
Sei whale	*Balaenoptera borealis*	Endangered	East Coast
Fin whale	*Balaenoptera physalus*	Endangered	East Coast and GOMEX
Blue whale	*Balaenoptera musculus*	Endangered	East Coast
Suborder Odontoceti (toothed whales)			
Family Physeteridae (sperm whale)			
Sperm whale	*Physeter macrocephalus*	Endangered	East Coast and GOMEX
Family Kogiidae			
Pygmy sperm whale	*Kogia breviceps*		East Coast and GOMEX
Dwarf sperm whale	*Kogia sima*		East Coast and GOMEX
Family Monodontidae (beluga whale and narwhal)			
Beluga whale	*Delphinapterus leucas*		East Coast
Family Ziphiidae (beaked whales)			
Cuvier's beaked whale	*Ziphius cavirostris*		East Coast and GOMEX
True's beaked whale	*Mesoplodon mirus*		East Coast
Gervais' beaked whale	*Mesoplodon europaeus*		East Coast and GOMEX
Sowerby's beaked whale	*Mesoplodon bidens*		East Coast
Blainville's beaked whale	*Mesoplodon densirostris*		East Coast and GOMEX
Northern bottlenose whale	*Hyperoodon ampullatus*		East Coast
Family Delphinidae (dolphins)			
Rough-toothed dolphin	*Steno bredanensis*		East Coast and GOMEX
Common bottlenose dolphin	*Tursiops truncatus*		East Coast and GOMEX
Pantropical spotted dolphin	*Stenella attenuata*		East Coast and GOMEX
Atlantic spotted dolphin	*Stenella frontalis*		East Coast and GOMEX
Spinner dolphin	*Stenella longirostris*		East Coast and GOMEX
Clymene dolphin	*Stenella clymene*		East Coast and GOMEX
Striped dolphin	*Stenella coeruleoalba*		East Coast and GOMEX
Common dolphin	*Delphinus delphis*		East Coast
Fraser's dolphin	*Lagenodelphis hosei*		East Coast and GOMEX
Risso's dolphin	*Grampus griseus*		East Coast and GOMEX
Atlantic white-sided dolphin	*Lagenorhynchus acutus*		East Coast and GOMEX
White-beaked dolphin	*Lagenorhynchus albirostris*		East Coast and GOMEX
Melon-headed whale	*Peponocephala electra*		East Coast and GOMEX
Pygmy killer whale	*Feresa attenuata*		East Coast and GOMEX
False killer whale	*Pseudorca crassidens*		East Coast and GOMEX
Killer whale	*Orcinus orca*		East Coast and GOMEX
Long-finned pilot whale	*Globicephala melas*		East Coast and GOMEX
Short-finned pilot whale	*Globicephala macrorhynchus*		East Coast and GOMEX
Order Carnivora			
Suborder Pinnipedia			
Family Phocidae (true seals)			
Harbor porpoise	*Phocoena phocoena*		East Coast
Hooded seal	*Cystophora cristata*		East Coast

Table 3-5. Marine Mammals with Possible or Confirmed Occurrence Along the East Coast and in the Gulf of Mexico, Cont'd

Common Name	Scientific Name	ESA Status	Possible Location
Order Carnivora Cont'd			
Suborder Pinnipedia Cont'd			
Family Phocidae (true seals) Cont'd			
Harp seal	*Pagophilus groenlandicus*		East Coast
Gray seal	*Halichoerus grypus*		East Coast
Harbor seal	*Phoca vitulina*		East Coast
Ringed seal	*Pusa hispida*		East Coast
Order Sirenia			
Family Trichechidae (manatees)			
West Indian manatee	*Trichechus manatus*	Endangered	East Coast and GOMEX

Source: DON, 2005, 2007a. 2007b, 2007c, and 2007d

3.6.1 Description of Marine Mammals Potentially Present Along the East Coast and in the Gulf of Mexico

The MRA data were used to provide a regional context for each species; however, animals may be found outside typical distribution ranges described within the MRA. These MRAs represent a compilation and synthesis of available scientific literature (e.g., journals, periodicals, theses, dissertations, project reports, and other technical reports published by government agencies, private businesses, or consulting firms), and NMFS reports, including stock assessment reports, recovery plans, and survey reports.

Of the marine mammals that may occur along the East Coast and Gulf of Mexico, six species of cetaceans, including five mysticete whales and one odontocete whale, and one sirenian species are currently listed as federally endangered. These species are the North Atlantic right whale, humpback whale, sei whale, fin whale, blue whale, sperm whale, and West Indian manatee.

Cetacean distribution is affected by demographic, evolutionary, ecological, habitat-related, and anthropogenic factors. Whale movements are often related to feeding or breeding activity. Some baleen whale species, such as humpback and North Atlantic right whales, make extensive annual migrations to low-latitude mating and calving grounds in the winter and to high-latitude feeding grounds in the summer. These migrations are thought to occur during these seasons due to the presence of highly productive waters and associated cetacean prey species at high latitudes and warm water temperatures at low latitudes. Not all baleen whales, however, migrate. Some individual fin (*B. physalus*) and blue (*B. musculus*) whales may stay year-round in a specific area. The timing of migration is often a function of age, sex, and reproductive class. Females tend to migrate earlier than males and adults earlier than immature animals. Since most toothed whales do not have the fasting capability of the baleen whales, toothed whales probably either follow seasonal shifts in preferred prey or are opportunistic feeders, taking advantage of whatever prey happens to be in the area.

Cetacean movements are often a reflection of the distribution and abundance of prey, and changes in cetacean distributions have been correlated with shifts in the distribution and abundance of prey (Gaskin, 1982; Payne et al., 1986; Kenney et al., 1996). Cetacean movements have also been linked to indirect indicators of prey, such as temperature variations, sea-surface chlorophyll concentrations, and features such as bottom depth (Fiedler, 2002). Movements in many areas may also be related to the presence of oceanographic features, such as upwelling events or warm-core rings (Biggs et al., 2000; Wormuth et al., 2000; Davis et al., 2002). The increased nutrient concentrations associated with upwelling results in areas of high primary productivity.

Pinnipeds do not normally range farther south .than the Northeast OPAREAs. It is speculated that any pinniped movement farther south would be because the collapsed fish stocks no longer support current high populations. In addition, California sea lions may exist in the mid-Atlantic United States as feral (i.e., non-native, introduced) individuals that escaped or were released from marine parks (Rowlett, 1980). This is very unlikely, however, and any individuals occurring here are not part of any natural wild populations.

The West Indian manatee generally reside along the Southeastern Atlantic coast and the Gulf of Mexico and may migrate farther north during warm months but would be limited primarily to nearshore waters.

3.6.1.1 Mysticetes

3.6.1.1.1 North Atlantic Right Whale (*Eubalaena glacialis*)

Description **–**North Atlantic right whale adults are robust and may reach 18 m (59 ft) in length (Jefferson et al., 1993). There is no dorsal fin on the broad back. The head is nearly one-third of its total body length. The jaw line is arched and the upper jaw is very narrow in dorsal view. Right whales are overall black in color although many individuals also have irregular white patches on their undersides (Reeves and Kenney, 2003). The head is covered with irregular, whitish patches called "callosities" that assist researchers in individual identification (Kraus et al., 1986).

Status **–** The north Atlantic right whale is one of the world's most endangered large whale species (Clapham et al., 1999; Perry et al., 1999; International Whaling Commission [IWC], 2001b). North Atlantic right whales are classified as endangered under the ESA (Waring et al., 2007).

Approximately 350 individuals, including about 70 mature females, are thought to occur in the western North Atlantic (Kraus et al., 2005). A May 2007 review of the photo-ID recapture database resulted in a minimum population size of 325 right whales in the Western North Atlantic (Waring et al., 2008). No estimate of abundance with an associated coefficient of variation has been calculated for the population (Waring et al., 2008).

There is evidence of modest population growth in the North Atlantic right whale population (Neuhauser, 2007). There is a slight upward trend in the minimum number of animals known to be alive during the time period 1995 to 2002 (Waring et al., 2008). There is also a statistical upward trend in the number of calves born since 1995, but with a large degree of interannual variation (Kraus et al., 2007).

In an effort to reduce ship collisions with critically endangered North Atlantic right whales, the Early Warning System (EWS) was started in 1994 for the calving region along the southeastern

U.S. coast. This system, known as the Northeast United State's Right Whale Sighting Advisory System in the northeast, was extended in 1996 to the feeding areas off New England (NMFS-NEFSC, 2008).

In 1999, a Mandatory Ship Reporting System was implemented by the U.S. Coast Guard (USCG) (USCG, 1999; USCG, 2001). This reporting system requires vessels larger than 300 gross registered tons (Navy ships are exempt) to report their location when entering the nursery and feeding areas of the right whale (Ward-Geiger et al., 2005). At the same time, ships receive information on locations of North Atlantic right whale sightings in order to avoid whale collisions. In the southeastern United States, the reporting system is from November 15 through April 15 of each year; the geographical boundaries include coastal waters within roughly 46 km (25 NM) of shore along a 167 km (90 NM) stretch of the Atlantic coast in Florida and Georgia. In the northeastern United States, the reporting system is year-round and the geographical boundaries include the waters of Cape Cod Bay, Massachusetts Bay, and the Great South Channel east and southeast of Massachusetts; it includes all of Stellwagen Bank National Marine Sanctuary. A portion of the Boston OPAREA falls within these boundaries.

Effective December 9, 2008 through December 9, 2013, speed restrictions of no more than 18.5 km/hr (10 kn) will apply to all vessels 19.8 m (65 ft) or greater in overall length in certain locations and at certain times of the year along the east coast of the U.S. Atlantic seaboard (NMFS, 2008i). The purpose of the regulations is to reduce the likelihood of deaths and serious injuries to North Atlantic right whales that result from collisions with ships. These restrictions are not mandatory for naval vessels (NMFS, 2008i). In addition, in July 2007, the east-west leg of the Boston Traffic Separation Scheme was shifted approximately 12 degrees north to redirect shipping traffic through the Stellwagen Bank NMS from an area of high whale density to an area of significantly lower whale density.

Diving Behavior – Dives of 5 to 15 minutes (min) or longer have been reported (CETAP, 1982; Baumgartner and Mate, 2003), but can be much shorter when feeding (Winn et al., 1995). Foraging dives in the known feeding high-use areas are frequently near the bottom of the water column (Goodyear, 1993; Mate et al., 1997; Baumgartner et al., 2003). Baumgartner and Mate (2003) found that the average depth of a right whale dive was strongly correlated with both the average depth of peak copepod abundance and the average depth of the mixed layer. Right whale feeding dives are characterized by a rapid descent from the surface to a particular depth between 80 and 175 m (262 to 574 ft), remarkable fidelity to that depth for 5 to 14 min, and then rapid ascent back to the surface (Baumgartner and Mate, 2003). Longer surface intervals have been observed for reproductively active females and their calves (Baumgartner and Mate, 2003). The longest tracking of a right whale is of an adult female that migrated 1,928 km (1,040 NM) in 23 days (mean was 3.5 km/hr [1.9 kn) from 40 km (22 NM) west of Browns Bank to Georgia (Mate and Baumgartner, 2001).

Acoustics and Hearing – North Atlantic right whales produce a variety of sounds, including moans, screams, gunshots, blows, upcalls, downcalls, and warbles that are often linked to specific behaviors (Matthews et al., 2001; Laurinolli et al., 2003; Vanderlaan et al., 2003; Parks et al., 2005; Parks and Tyack, 2005). Sounds can be divided into three main categories: (1) blow sounds; (2) broadband impulsive sounds; and (3) tonal call types (Parks and Clark, 2007). Blow sounds are those coinciding with an exhalation; it is not known whether these are intentional communication signals or just produced incidentally (Parks and Clark, 2007). Broadband sounds include non-vocal slaps (when the whale strikes the surface of the water with parts of its body) and the "gunshot" sound; data suggests that the latter serves a communicative purpose (Parks and Clark, 2007). Tonal calls can be divided into simple, low-frequency, stereo-typed calls and more complex, frequency-modulated, higher-frequency calls (Parks and Clark, 2007). Most of these sounds range in frequency from 0.02 to 15 kHz (dominant frequency range from 0.02 to less than 2 kHz; durations typically range from 0.01 to multiple seconds) with some sounds having multiple harmonics (Parks and Tyack, 2005). Source levels for some of these sounds have been measured as ranging from 137 to 192 dB root-mean-square (rms) re 1 μPa-m (decibels at the reference level of one micro Pascal at one meter) (Parks et al., 2005; Parks and Tyack, 2005). Research by Parks and Clark (2005) in the western North Atlantic (Cape Cod Bay, Great South Channel, and Bay of Fundy) suggests that the frequency of right whale vocalizations increases significantly during the period from dusk until dawn.

Recent morphometric analyses of North Atlantic right whale inner ears estimates a hearing range of approximately 0.01 to 22 kHz based on established marine mammal models (Parks et al., 2004; Parks and Tyack, 2005; Parks et al., 2007). In addition, Parks et al. (2007) estimated the functional hearing range for right whales to be 15 Hz to 18 kHz. Nowacek et al. (2004) observed that exposure to short tones (alerts) and social sounds, ranging in frequency from 0.5 to 4.5 kHz, induced an alteration in dive behavior from strong to mild, respectively; however, exposure to sounds produced by vessels (dominant frequency range of 0.05 to 0.5 kHz), or to actual approaching vessels, did not produce any behavioral response

Distribution **–** Right whales occur in sub-polar to temperate waters. The North Atlantic right whale was historically widely distributed, ranging from latitudes of 60°N to 20°N, prior to serious declines in abundance due to intensive whaling (e.g., NMFS, 2006c; Reeves et al., 2007). North Atlantic right whales are found primarily in continental shelf waters between Florida and Nova Scotia (Winn et al., 1986). Most sightings are concentrated within five high-use areas: coastal waters of the southeastern United States. (Georgia and Florida), Cape Cod and Massachusetts bays, the Great South Channel, the Bay of Fundy, and the Nova Scotian Shelf (Winn et al., 1986; NMFS, 2005b). There are documented records for this species in the Gulf of Mexico; mother/calf pairs have been sighted as far west as Texas (Zoodsma, 2006).

Most North Atlantic right whale sightings follow a well-defined seasonal migratory pattern through several consistently utilized habitats (Winn et al., 1986). It should be noted, however, that some individuals may be sighted in these habitats outside the typical time of year and that migration routes are poorly known (there may be a regular offshore component). The population migrates as two separate components, although some whales may remain in the feeding grounds throughout the winter (Winn et al., 1986; Kenney et al., 2001). Pregnant females and some juveniles migrate from the feeding grounds to the calving grounds off the southeastern United States in late fall to winter. The cow-calf pairs return northward in late winter to early spring. The majority of the right whale population leaves the feeding grounds for unknown habitats in the winter but returns to the feeding grounds coinciding with the return of the cow-calf pairs. North Atlantic right whales are found commonly on feeding grounds off the northeastern United States and Canada. During the early spring and summer, individuals are most abundant in Cape Cod Bay (February and April) (Winn et al., 1986; Hamilton and Mayo, 1990) and in the Great South Channel east of Cape Cod (April through June) (Winn et al., 1986; Kenney et al., 1995).

Throughout the remainder of summer and into fall (June through November), North Atlantic right whales are most commonly seen further north on feeding grounds in Canadian waters (Gaskin, 1987 and 1991). The peak abundance of right whales in this are occurs during August, September, and early October. The majority of summer and fall sightings of mother/calf pairs in Canadian waters occur east of Grand Manan Island in the Bay of Fundy (Schaeff et al., 1993). Jeffreys Ledge is also important habitat for right whales in Canadian waters and serves as a nursery area during the summer (Weinrich et al., 2000). Primary feeding grounds for North Atlantic right whales in Canadian waters are found off the southern tip of Nova Scotia in the Roseway Basin between Browns, Baccaro, and Roseway banks (Mitchell et al., 1986; Gaskin, 1987; Stone et al., 1988; Gaskin, 1991). The feeding grounds off Cape Cod Bay and the Great South Channel are designated as critical habitat for the North Atlantic right whale (NMFS, 2005b).During the winter (as early as November and through March), North Atlantic right whales may be found in coastal waters off North Carolina, South Carolina, Georgia, and northern Florida (Winn et al., 1986). The waters off Georgia and northern Florida are the only known calving ground for western North Atlantic right whales; it is formally designated as a critical habitat under the ESA. Calving occurs from December through March (NMFS, 2005b). On January 1, 2005, the first observed birth on the calving grounds was reported (Zani et al., 2008). The majority of the population is not accounted for on the calving grounds, and not all reproductively active females return to this area each year (Kraus et al., 1986).

The coastal waters of the Carolinas are suggested to be a migratory corridor for the right whale (Winn et al., 1986). The Southeast U.S. Coast Ground, consisting of coastal waters between North Carolina and northern Florida, was mainly a winter and early spring (January-March) right whaling ground during the late 1800s (Reeves and Mitchell, 1986). The whaling ground was centered along the coasts of South Carolina and Georgia (Reeves and Mitchell, 1986). An examination of sighting records from all sources between 1950 and 1992 found that wintering right whales were observed widely along the coast from Cape Hatteras, North Carolina, to Miami, Florida (Kraus et al., 1993). Sightings off the Carolinas were comprised of single individuals that appeared to be transients (Kraus et al., 1993). These observations are consistent with the hypothesis that the coastal waters of the Carolinas are part of a migratory corridor for the right whale (Winn et al., 1986). Knowlton et al. (2002) analyzed sightings data collected in the mid-Atlantic from northern Georgia to southern New England and found that the majority of right whale sightings occurred within approximately 56 km (30 NM) from shore. Until better information is available on the right whale's migratory corridor, it has been recommended that management considerations are needed for the coastal areas along the mid-Atlantic migratory corridor within 65 km (35 NM) from shore (Knowlton, 1997).

Radio-tagged animals have made extensive movements, sometimes traveling from the Gulf of Maine into deeper waters off the continental shelf (Mate et al., 1997). Mate et al. (1997) tagged one male that traveled into waters with a bottom depth of 4,200 m (13,780 ft). Long-distance movements as far north as Newfoundland, the Labrador Basin, southeast of Greenland, Iceland, and Arctic Norway have been documented (Knowlton et al., 1992; IWC, 2001a; Waring et al., 2007). One individually identified right whale was documented to make a two-way trans-Atlantic migration from the East Coast to a location in northern Norway (Jacobsen et al., 2004). A female North Atlantic right whale was tagged with a satellite transmitter and tracked to nearly the middle of the Atlantic where she remained for a period of months (WhaleNet, 1998).

Critical habitat for the population of the North Atlantic right whale exists in portions of the JAX/CHASN and Northeast OPAREAs (Figures 3-4 and 3-5). The following three areas occur in U.S. waters and were designated by NMFS as critical habitat in June 1994 (NMFS, 2005b):

(1) Coastal Florida and Georgia (Sebastian Inlet, Florida, to the Altamaha River, Georgia),

(2) The Great South Channel, east of Cape Cod, and

(3) Cape Cod and Massachusetts Bays.

The northern critical habitat areas serve as feeding and nursery grounds, while the southern area serves as calving grounds. The waters off Georgia and northern Florida are the only known calving ground for western North Atlantic right whales. A large portion of this habitat lies within the coastal waters of the JAX/CHASN OPAREA. The physical features correlated with the distribution of right whales in the southern critical habitat area provide an optimum environment for calving. For example, the bathymetry of the inner and nearshore-middle shelf area minimizes the effect of strong winds and offshore waves, limiting the formation of large waves and rough water. The average temperature of critical habitat waters is cooler during the time right whales are present due to a lack of influence by the Gulf Stream and cool freshwater runoff from coastal areas. NMFS theorizes the water temperatures provide an optimal balance between offshore waters that are too warm for nursing mothers to tolerate, yet not too cool for calves that may only have minimal fatty insulation (NMFS, 1994). On the calving grounds, the reproductive females and calves are expected to be concentrated near the critical habitat in the JAX/CHASN OPAREA from December through April.

Atlantic Ocean, Offshore of the Southeastern United States

Right whales generally occur in the VACAPES and CHPT OPAREAs between November and April, when these whales transit the area on their migrations to and from breeding grounds in the south and the feeding grounds in the north. Because not all of the known North Atlantic right whales winter in the south in any particular year, the number of whales passing through the area can fluctuate from year to year. Based on sighting data, North Atlantic right whales are most likely to occur in shallower waters (shore to the 200-m [656-ft] isobath). Because the population of the North Atlantic right whale is so low, it is expected to be found only rarely along the migratory corridor.

The coastal waters off Georgia and Florida are the only known calving ground for the North Atlantic right whale. During the winter (as early as November and through April), right whales may be found in coastal waters off North Carolina, Georgia, and northern Florida, and calving occurs December through March. Right whales on the winter calving grounds are primarily limited to coastal waters.

Atlantic Ocean, Offshore of the Northeastern United States

North Atlantic right whales occur primarily in Cape Cod Bay, Great South Channel, Jeffreys Ledge and Bank, Georges Basin, Roseway Basin, and the Bay of Fundy, with increasing occurrences at Roseway Basin and Bay of Fundy. The two feeding areas adjacent to Massachusetts Bay in the Boston OPAREA are designated as critical habitat for North Atlantic right whales under the ESA.

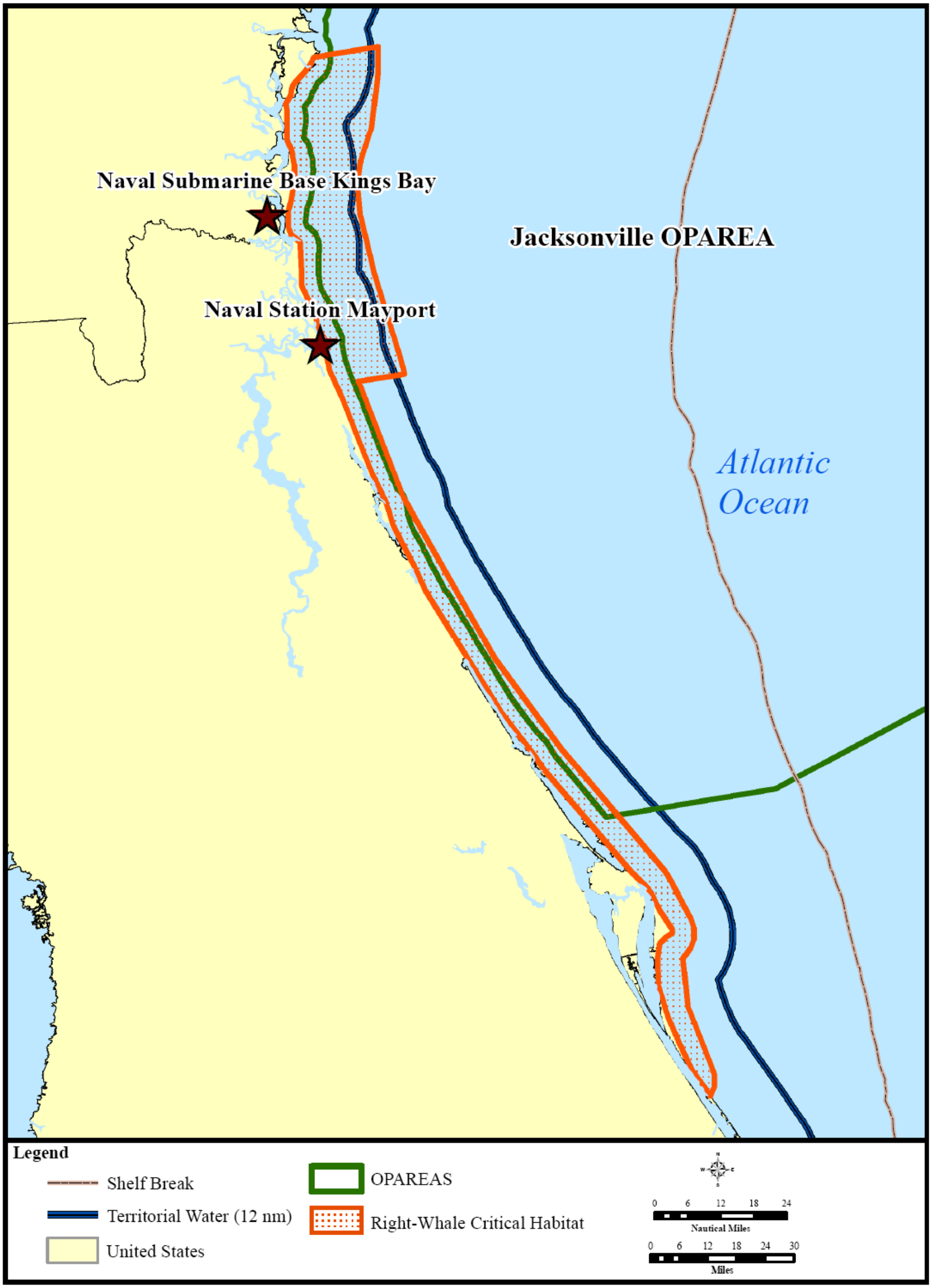


Figure 3-4. Southeast North Atlantic Right Whale Critical Habitat

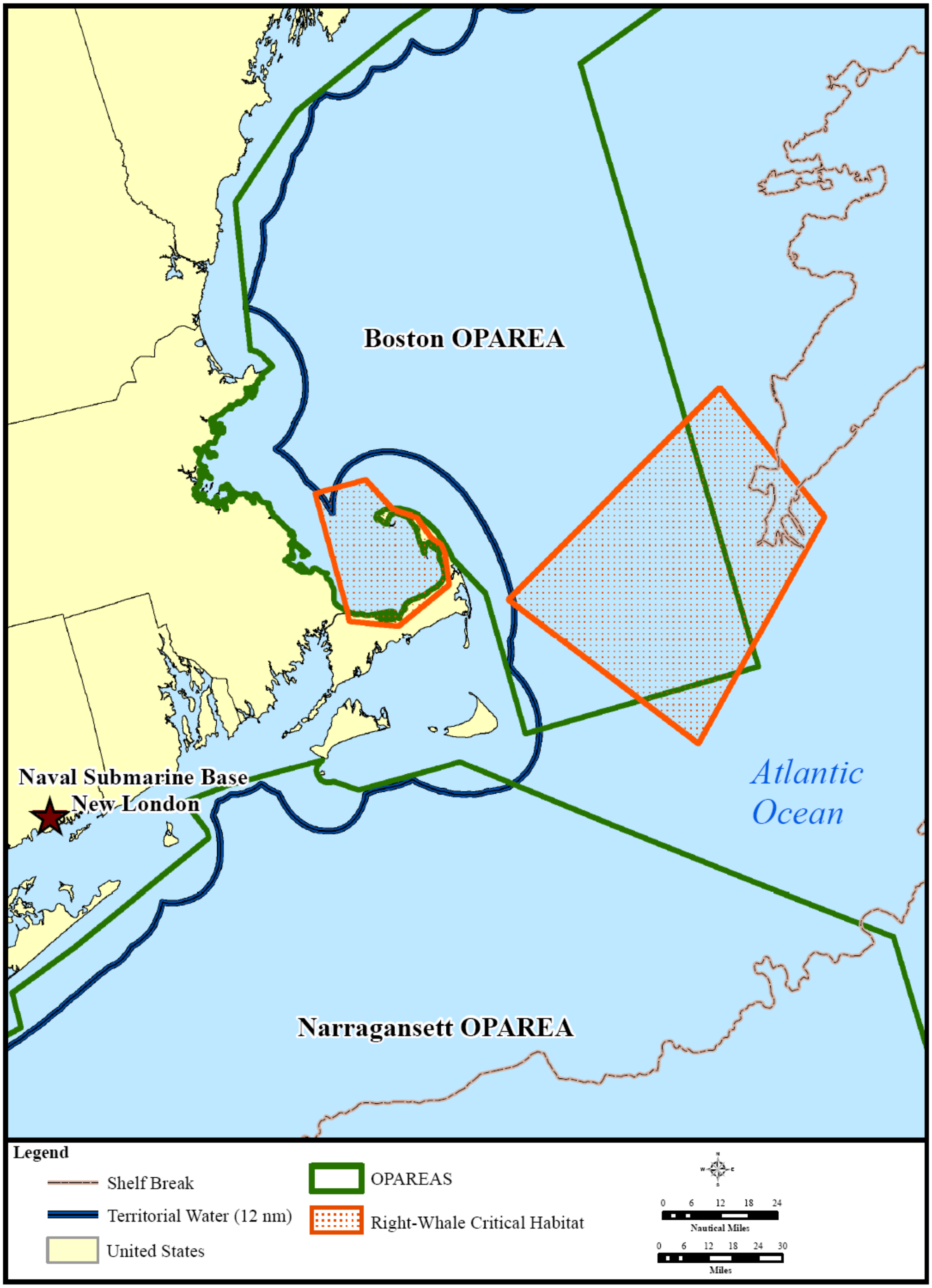


Figure 3-5. Northeast North Atlantic Right Whale Critical Habitat

During the wintertime, North Atlantic right whales can be expected to occur in inner continental shelf waters from the western Gulf of Maine south to Cape Cod Bay, Massachusetts Bay, and the Great South Channel. Right whales may also occur off southern New England, in the Narragansett Bay OPAREA, and in the waters off Maryland and Virginia. The occurrences in the Mid-Atlantic Bight (MAB) may represent whales migrating between the calving grounds off Florida and the feeding grounds in the northern New England. Cape Cod Bay is a known high-use area and the right whale occurrence peaks in the bay in late March (Hamilton and Mayo, 1990).

During the springtime, the general occurrence of right whales extends from waters over the continental shelf from the Bay of Fundy to Nantucket Shoals. Cape Cod Bay and the Great South Channel are known right whale feeding areas (CETAP, 1982; Hamilton and Mayo, 1990). Locations of preferred habitat may change based on the variance in temporal and spatial formations of zooplankton concentrations responding to annual fluctuations in oceanic conditions (Kenney, 2001). For example, during 1992, there were no right whales seen in the Great South Channel, and the only right whales seen in this region were in the central Gulf of Maine (Kenney, 2001).

In the summertime, right whales generally occur in the continental shelf waters from the Bay of Fundy and the Scotian Shelf to the southern tip of New Jersey. The highest occurrences of right whales are found in the Bay of Fundy. Known high abundance areas are in the Grand Manan Basin (east of Grand Manan Island in the lower Bay of Fundy) and in the Roseway Basin.
In the fall, right whales are generally found in the continental shelf waters from the Bay of Fundy and Roseway Basin to Maryland. Right whales are present through at least mid-October on their feeding grounds located in the Northeast Atlantic.

GOMEX

There are five confirmed sightings of the North Atlantic right whale in the GOMEX; all of them occurred in winter and spring, including one stranding on the Texas coast in 1972 (Schmidly et al., 1972; Zoodsma, 2006). Three of the sightings were of cow-calf pairs. One pair seen in late January 2004 off Miami, Florida and in mid-March to early April off the Florida Panhandle was later resighted in June in waters off Cape Cod (Anonymous, 2004). More recently, a cow-calf pair was photographed in Corpus Christi Bay off southern Texas and sighted a few weeks later off Long Boat Key, Florida (NOAA and FWC, 2006; Zoodsma, 2006). These occurrences likely represent individuals wandering from the wintering grounds or might even reflect a more extensive historic range beyond the known calving and wintering ground in the waters of the southeastern United States (Jefferson and Schiro, 1997; Waring et al., 2008). The North Atlantic right whale occurs very rarely in the GOMEX.

3.6.1.1.2 Humpback Whale (*Megaptera novaeangliae*)

Description **–** Adult humpback whales are 11 to 16 m (36 to 52 ft) in length and are more robust than other rorquals. The body is black or dark gray, with very long (about one-third of the body length) flippers that are usually at least partially white (Jefferson et al., 1993; Clapham and Mead, 1999). The head is larger than in other rorquals. The flukes have a concave, serrated trailing edge; the ventral side is variably patterned in black and white. Individual humpback whales may be identified using these patterns (Katona et al., 1979). The triangular to falcate dorsal fin is set far back on the body behind a long hump.

Status – Humpback whales are classified as endangered under the ESA (NMFS, 1991). An estimated 11,570 humpback whales occur in the entire North Atlantic (Stevick et al., 2003a). NMFS recognizes the Gulf of Maine population of humpback whales as a distinct feeding stock within the North Atlantic (Waring et al., 2008). Humpback whales in the North Atlantic are thought to belong to six different feeding stocks: Gulf of Maine, Gulf of St. Lawrence, Newfoundland/Labrador, western Greenland, Iceland, and Norway (Larsen et al., 1996; Waring et al., 2008). There appears to be very little exchange between these separate feeding stocks (Katona and Beard, 1990). The best estimate of abundance for the Gulf of Maine Stock is 847 individuals (Waring et al., 2008); this number is based on line-transect surveys conducted in 1999 (Clapham et al., 2003). There is no designated critical habitat for this species.

Diving Behavior – Humpback whale diving behavior depends on the time of year (Clapham and Mead, 1999). In summer, most dives last less than 5 min; those exceeding 10 min are atypical. In winter (December through March), dives average 10 to 15 min; dives of greater than 30 min have been recorded (Clapham and Mead, 1999). Although humpback whales have been recorded to dive as deep as 500 m (1,640 ft) (Dietz et al., 2002), on the feeding grounds they spend the majority of their time in the upper 120 m (394 ft) of the water column (Dolphin, 1987; Dietz et al., 2002). Recent D-tag work revealed that humpbacks were found foraging only a few meters below the water's surface (Ware et al., 2006). On wintering grounds, Baird et al. (2000) recorded dives deeper than 100 m (328 ft).

Acoustics and Hearing – Humpback whales are known to produce three classes of vocalizations: (1) "songs" in the late fall, winter, and spring by solitary males; (2) sounds made within groups on the wintering (calving) grounds; and (3) social sounds made on the feeding grounds (Thomson and Richardson, 1995).

The best-known types of sounds produced by humpback whales are songs, which are thought to be breeding displays used only by adult males (Helweg et al., 1992). Singing is most common on breeding grounds during the winter and spring months, but is occasionally heard outside breeding areas and out of season (Mattila et al., 1987; Gabriele et al., 2001; Gabriele and Frankel, 2002; Clark and Clapham, 2004). Humpback song is an elaborate series of patterned vocalizations, which are hierarchical in nature (Payne and McVay, 1971). There is geographical variation in humpback whale song, with different populations singing different songs, and all members of a population using the same basic song. However, the song evolves over the course of a breeding season, but remains nearly unchanged from the end of one season to the start of the next (Payne et al., 1983).

Social calls are from 50 Hz to over 10 kHz, with dominant frequencies below 3 kHz (Silber, 1986). Female vocalizations appear to be simple; Simão and Moreira (2005) noted little complexity. The male song, however, is complex and changes between seasons. Components of the song range from under 20 Hz to 4 kHz and occasionally 8 kHz, with source levels measured between 151 and 189 dB re 1 μPa-m and high-frequency harmonics extending beyond 24 kHz (Au et al., 2001; Au et al., 2006). Songs have also been recorded on feeding grounds (Mattila et al., 1987; Clark and Clapham, 2004). The main energy lies between 0.2 and 3.0 kHz, with frequency peaks at 4.7 kHz. "Feeding" calls, unlike song and social sounds, are highly stereotyped series of narrow-band trumpeting calls. These calls are 20 Hz to 2 kHz, less than 1 sec in duration, and have source levels of 162 to 192 dB re 1 μPa-m. The fundamental frequency of feeding calls is approximately 500 Hz (D'Vincent et al., 1985; Thompson et al., 1986). More recently, the acoustics and dive profiles associated with humpback whale feeding behavior in the northwest Atlantic has been documented with DTAGs (Stimpert et al., 2007). Underwater lunge behavior was associated with nocturnal feeding at depth and with multiple bouts of broadband click trains that were acoustically different from toothed whale echolocation: Stimpert et al. (2007) termed these sounds "mega-clicks" which showed relatively low received levels at the DTAGs with the majority of acoustic energy below 2 kHz. More data are required to facilitate a more complete understanding of this newly-described acoustic, dive and feeding behavior of humpback whales.

While no measured data on hearing ability are available for this species, Ketten (1997) hypothesized that mysticetes have acute infrasonic hearing. Houser et al. (2001) produced the first humpback whale audiogram (using a mathematical model). The predicted audiogram indicates sensitivity to frequencies from 700 Hz to 10 kHz, with maximum relative sensitivity between 2 and 6 kHz. Au et al. (2006) noted that if the popular notion that animals generally hear the totality of the sounds they produce is applied to humpback whales, this suggests that its upper frequency limit of hearing is as high as 24 kHz.

Distribution **–** Humpback whales are globally distributed in all major oceans and most seas. They are generally found during the summer on high-latitude feeding grounds and during the winter in the tropics and subtropics around islands, over shallow banks, and along continental coasts, where calving occurs. Most humpback whale sightings are in nearshore and continental shelf waters; however, humpback whales frequently travel through deep water during migration (Clapham and Mattila, 1990; Calambokidis et al., 2001).

In the North Atlantic Ocean, humpbacks are found from spring through fall on feeding grounds that are located from south of New England to northern Norway (NMFS, 1991). The Gulf of Maine is one of the principal summer feeding grounds for humpback whales in the North Atlantic. The largest numbers of humpback whales are present from mid-April to mid-November. Feeding locations off the northeastern United States include Stellwagen Bank, Jeffreys Ledge, the Great South Channel, the edges and shoals of Georges Bank, Cashes Ledge, Grand Manan Banks, the banks on the Scotian Shelf, the Gulf of St. Lawrence, and the Newfoundland Grand Banks (CETAP, 1982; Whitehead, 1982; Kenney and Winn, 1986; Weinrich et al., 1997). Distribution in this region has been largely correlated to prey species and abundance, although behavior and bottom topography are factors in foraging strategy (Payne et al., 1986; Payne et al., 1990a). Humpbacks typically return to the same feeding areas each year.

The distribution and abundance of sand lance are important factors underlying the distribution patterns of the humpback whale (Kenney and Winn, 1986). Changes in diets and feeding preferences are likely caused by changes in prey distribution and/or in the relative abundance of different prey species (sand lance and herring) (Payne et al., 1986; Payne et al., 1990a; Kenney et al., 1996; Weinrich et al., 1997). Feeding most often occurs in relatively shallow waters over the inner continental shelf and sometimes in deeper waters. Large multi-species feeding aggregations (including humpback whales) have been observed over the shelf break on the southern edge of Georges Bank (CETAP, 1982; Kenney and Winn, 1987) and in shelf break waters off the U.S. mid-Atlantic coast (Smith et al., 1996).

During the winter, most of the North Atlantic population of humpback whales are believed to migrate south to calving grounds in the West Indies region (Whitehead and Moore, 1982; Smith et al., 1999; Stevick et al., 2003b). Due to the temporal difference in occupancy of the West Indies between individuals from different feeding areas, coupled with sexual differences in migratory patterns, Stevick et al. (2003b) suggested the possibility that there are reduced mating opportunities between individuals from different high-latitude feeding areas. The calving peak is January through March, with some animals arriving as early as December and a few not leaving until June. The mean sighting date in the West Indies for individuals from the United States and Canada is February 16 and 15, respectively (Stevick et al., 2003b).

Apparently, not all Atlantic humpback whales migrate to the calving grounds, since some sightings (believed to be only a very small proportion of the population) are made during the winter in northern habitats (CETAP, 1982; Whitehead, 1982; Clapham et al., 1993; Swingle et al., 1993). The sex/age class of nonmigratory animals remains unclear. A small number of individuals remain in the Gulf of Maine during winter (CETAP, 1982; Clapham et al., 1993); however, it is not known whether these few sightings represent winter residents or either late-departing or early-arriving migrants (Mitchell et al., 2002).

There has been an increasing occurrence of humpbacks, which appear to be primarily juveniles, during the winter along the U.S. Atlantic coast from Florida north to Virginia (Clapham et al., 1993; Swingle et al., 1993; Wiley et al., 1995; Laerm et al., 1997). Strandings of humpbacks (mainly juveniles) in this area have also increased (Wiley et al., 1995). Further, a number of winter humpback whale sightings have occurred in coastal southeastern U.S. waters (Waring et al., 2008). A humpback whale was also sighted in the Tongue of the Ocean (Bahamas) during marine mammal surveys (Mobley, 2004). There are also reports of humpback whales in the GOMEX, particularly near the Panhandle region of Florida, during this time of year (Weller et al., 1996a; MMS, 2001; Pitchford, 2006). None of these occurrences are fully understood. They might be due to shifts in distribution, increases in sighting effort, or habitat that is becoming increasingly important for juveniles (Wiley et al., 1995). Sighting histories of mature humpback whales suggest that the mid-Atlantic area contains a greater percentage of mature animals than is represented by strandings (Barco et al., 2002). It has recently been proposed that the mid-Atlantic region primarily represents a supplemental winter feeding ground, which is also an area of mixing of humpback whales from different feeding stocks (Barco et al., 2002).

The routes taken during the southbound and northbound migrations are not known. Examination of whaling catches revealed that both northward and southward migrations are characterized by a staggering of sexual and maturational classes; lactating females are among the first to leave summer feeding grounds in the fall, followed by subadult males, mature males, non-pregnant females, and pregnant females (Clapham, 1996). On the northward migration, this order is broadly reversed, with newly pregnant females among the first to begin the return migration to high latitudes. Stevick et al. (2003b) reported sighting males 6.63 days earlier in the West Indies than females. Individuals identified on feeding grounds in the Gulf of Maine and eastern Canada arrived significantly earlier (9.97 days) than those animals identified in Greenland, Iceland, and

Norway (Stevick et al., 2003b). During the northward migration, the whales are not believed to separate into discrete feeding groups until north of Bermuda (Katona and Beard, 1990).

Atlantic Ocean, Offshore of the Southeastern United States

Along the southeastern United States, most humpback whale sightings are generally in nearshore and continental shelf waters, though it is likely that at least some part of the migration is through the open ocean.

There has been an increasing occurrence of (primarily juvenile) humpback whales during the winter along the U.S. Atlantic coast from Florida north to Virginia. Strandings of humpbacks (mainly juveniles) in this area have also increased in recent years. It has recently been proposed that the mid-Atlantic region may represent a supplemental winter feeding ground, which is also an area of mixing of humpback whales from different feeding stocks (Barco et al., 2002).

The humpback whales may occur in the VACAPES OPAREA in all seasons, although they are least likely to be found there in the summer, when they are generally located at their feeding grounds to the north. Sighting data in the VACAPES OPAREA indicate that these whales are mainly distributed in nearshore and continental shelf waters, but are found as well as open-ocean waters on and outside the shelf edge (the 200-m [656-ft] isobath). The majority of offshore sightings occurred in the spring and fall. Humpbacks are presumed to make their seasonal north/south migrations in the more direct route through deeper offshore waters, and this is the most likely explanation for sightings in deep water during the fall and spring.

Based on sighting data for the CHPT OPAREA and the nearby vicinity, humpback whales may occur on the continental shelf, as well as farther offshore, during fall, winter, and spring, which takes into consideration humpbacks migrating to calving grounds in the Caribbean during the fall and making return migrations to the feeding grounds much farther north during the spring. Humpback whales most likely do not occur in the CHPT OPAREA during summer, since they should occur farther north, at their feeding grounds.

Based on sightings and strandings, the humpback whale may occur throughout the JAX/CHASN OPAREA during fall, winter, and spring. Humpback whales are not expected in the JAX/CHASN OPAREA during the summer; instead, they are expected to be on their feeding grounds further north.

Atlantic Ocean, Offshore of the Northeastern United States

Humpback whales occur in the Gulf of Maine, in the continental shelf waters from the Bay of Fundy and the Scotian Shelf to the southern extent of the Northeast OPAREAs. Overall, spring and summer have the highest occurrences of whales, while winter has the lowest.

In the winter, humpback whales generally occur in continental shelf waters from the southern region of the Gulf of Maine to Virginia. There occurrences of humpback whales have been recorded primarily over the continental shelf in the Gulf of Maine, in Cape Cod and Massachusetts Bays, Great South Channel, over Stellwagen Bank, Jeffreys Ledge, and Georges

Bank (CETAP, 1982; Clapham et al., 1993). The occurrences south of the Gulf of Maine may represent whales in transit.

In the spring, humpback whales primarily occur in the continental shelf waters from the Bay of Fundy and the Scotian Shelf to New Jersey. The greatest concentrations may occur in the western and southern perimeter of Gulf of Maine, just northeast of the Narragansett Bay OPAREA. The occurrences south of the Gulf of Maine may represent whales in transit.

During the summertime, humpback whales can be expected in the continental shelf waters, from the Bay of Fundy and the Scotian Shelf to the southern tip of New Jersey. Humpback whales may be found in increased concentrations during the summer on the eastern, southern, and western perimeter of the Gulf of Maine, with the greatest concentration occurring east of Cape Cod. Occurrence records also show that humpback whales may occur in the northern region of the Narragansett Bay OPAREA, and near the coast from Long Island to northern Virginia.

In fall, the general occurrence of humpback whales extends from the Bay of Fundy and the Scotian shelf to the northwestern region of the Narragansett Bay OPAREA, in the continental shelf waters. During this season, humpback whales may be found in greater concentrations in the southern and western region of the Gulf of Maine, including Cape Cod Bay.

GOMEX

Any occurrences of the humpback whale in the GOMEX are considered to be extralimital. The western-most sighting of a humpback whale in the GOMEX was made in February 1992 off Galveston, Texas (Weller et al., 1996a). There are at least 19 additional reports of humpback whales in the Gulf, mostly from the Florida Panhandle region. Reports include a stranding east of Destin in mid-April 1998, a confirmed sighting of six humpback whales in May 1998 near DeSoto Canyon, and a handful of sightings during spring 2006 (MMS, 2001; Pitchford, 2006). In February 2004, a known Gulf of Maine humpback was sighted off the west coast of Florida, and it was resighted in the Gulf of Maine that September (Guinta, 2006). Weller et al speculated that humpbacks sighted in the GOMEX are likely juveniles that have wandered into the GOMEX from the nearby Caribbean Sea and Atlantic Ocean during the breeding season or on their migration northward (Weller et al., 1996a; Jefferson and Schiro, 1997). However, a review of the available records suggests that such occurrences could actually occur during any time of the year.

3.6.1.1.3 Common Minke Whale (*Balaenoptera acutorostrata*)

Description – Minke whales are small rorquals; adults reach lengths of just over 9 m (30 ft) (Jefferson et al., 1993). The head is pointed, and the median head ridge is prominent. The dorsal fin is tall (for a baleen whale), falcate, and located about two-thirds of the way back from the snout tip (Jefferson et al., 1993). The minke whale is dark gray dorsally, white beneath, with streaks of intermediate shades on the sides (Stewart and Leatherwood, 1985). Common minke whales may be distinguished from Antarctic minke whales (B. bonaerensis) by the bright white patch on the pectoral flippers; this coloration is generally present on both the standard and dwarf forms of the common minke whale but absent in the Antarctic species (Jefferson et al., 2008).

Status **–** There are four recognized stocks in the North Atlantic Ocean: Canadian East Coast, West Greenland, Central North Atlantic, and Northeastern North Atlantic (Donovan, 1991; Waring et al., 2008). Common minke whales found along the eastern coast of the U.S. are from the Canadian East Coast stock. This stock ranges from the Davis Strait south to the GOMEX (Waring et al., 2008).GOMEX The best estimate of abundance for the Canadian East Coast stock is 3,312 individuals (Waring et al., 2008).

Diving Behavior – Diel and seasonal variation in surfacing rates are documented for this species; this is probably due to changes in feeding patterns (Stockin et al., 2001). Dive durations of 7 to 380 seconds (sec) are recorded in the eastern North Pacific and the eastern North Atlantic (Lydersen and Øritsland, 1990; Stern, 1992; Stockin et al., 2001). Mean time at the surface averages 3.4 sec (S.D. was $\pm$ 0.3 sec) (Lydersen and Øritsland, 1990). Stern (1992) described minke whale surfacing patterns consisting of about four surfacings separated by short dives averaging 38 sec, followed by a longer dive of about 2-6 min.

Acoustics and Hearing – Recordings of minke whale sounds indicate the production of both high- and low-frequency sounds (range of 0.06 to 20 kHz) (Beamish and Mitchell, 1973; Winn and Perkins, 1976; Thomson and Richardson, 1995; Mellinger et al., 2000). Minke whale sounds have a dominant frequency range of 0.06 to greater than 12 kHz, depending on sound type (Thomson and Richardson, 1995; Edds-Walton, 2000). Mellinger et al. (2000) described two basic forms of pulse trains: a "speed-up" pulse train (dominant frequency range: 0.2 to 0.4 kHz) with individual pulses lasting 40 to 60 msec, and a less common "slow-down" pulse train (dominant frequency range: 50 to 0.35 kHz) lasting for 70 to 140 msec. Source levels for this species have been estimated to range from 151 to 175 dB re 1 μPa-m (Ketten, 1998). Gedamke et al. (2001) recorded a complex and stereotyped sound sequence ("star-wars vocalization") in the Southern Hemisphere that spanned a frequency range of 50 Hz to 9.4 kHz. Broadband source levels between 150 and 165 dB re 1 μPa-m were calculated for this star-wars vocalization. "Boings" recorded in the North Pacific have many striking similarities to the star-wars vocalization in both structure and acoustic behavior. "Boings" are produced by minke whales and are suggested to be a breeding display, consisting of a brief pulse at 1.3 kHz followed by an amplitude-modulated call with greatest energy at 1.4 kHz, with slight frequency modulation over a duration of 2.5 sec (Rankin and Barlow, 2005).

While no empirical data on hearing ability for this species are available, Ketten (1997) hypothesized that mysticetes are most adapted to hear low to infrasonic frequencies.

Distribution **–** Minke whales are distributed in polar, temperate, and tropical waters (Stewart and Reeves, 1985); they are less common in the tropics than in cooler waters. This species is more abundant in New England waters rather than the mid-Atlantic (Hamazaki, 2002; CETAP, 1982). The southernmost sighting in recent NMFS shipboard surveys was of one individual offshore of the mouth of Chesapeake Bay, in waters with a bottom depth of 3,475 m (11,401 ft) (Mullin and Fulling, 2003).

There appears to be a strong seasonal component to minke whale distribution (Horwood, 1990). Spring and summer are periods of relatively widespread distribution, and when they are most abundant off the northeastern United States. During fall in New England waters, there are fewer minke whales, and during early winter (January and February), the species appears to be largely absent from this area (Waring et al., 2008). Minke whales off the U.S. Atlantic Coast apparently migrate offshore and southward in winter (Mitchell, 1991; Mellinger et al., 2000). Clark and Gagnon (2004) reported that based on acoustics data, minke whales move clockwise through the Caribbean from winter into spring. Minke whales are known to occur during the winter months (November through March) in the western North Atlantic from Bermuda to the West Indies (Winn and Perkins, 1976; Mitchell, 1991; Mellinger et al., 2000).

Atlantic Ocean, Offshore of the Southeastern United States

The minke whale is only occasionally found in the mid-Atlantic area and only on a widely scattered basis. Most minke whale sightings in the VACAPES OPAREA were on the continental shelf, with only a few sightings past the shelf break. It appears that minke whale could occur during any season.

In the CHPT OPAREA, there has been only one reported minke whale sighting, which occurred along the northern edge of the OPAREA. There have also been a few strandings reported north of Cape Hatteras. During the winter, minke whales are sighted both north and south of the CHPT OPAREA. During spring and fall, the minke whales are most likely found north of the CHPT OPAREA. During the summer, minke whales are expected to occur at higher latitudes, on their feeding grounds. The minke whale is most likely to occur in the CHPT OPAREA during the winter.

Winter is the only season with recorded minke whale sightings in the JAX/CHASN OPAREA. During the summer, these whales, like other large baleen whales, are expected to occur at their feeding grounds in higher latitudes.

Atlantic Ocean, Offshore of the Northeastern United States

Minke whales may occur throughout the Northeast OPAREAs in continental shelf and slope waters. Overall, spring and summer have the greatest occurrences of minke whales, while winter has the lowest.

In the spring, the general occurrence of minke whales extends from waters over the continental shelf to the continental slope, from the Bay of Fundy and Browns Bank south to the VACAPES OPAREA. Minke whales may also occur in the deeper waters of the southern region of the northeastern United States. During this season, minke whales may be found in greater concentration in the western, southern, and eastern perimeter of the Gulf of Maine, Browns Bank; with the greatest concentrations found in the Bay of Fundy. The western North Atlantic is important feeding habitat for this species during this season (Murphy, 1995; Waring et al., 2004; Sergeant, 1963; Stewart and Leatherwood, 1985).

During summer, minke whales are thought to occur primarily over the continental shelf and slope in waters from the Bay of Fundy and the Scotian Shelf south to the VACAPES OPAREA. Minke whales may occur in greater concentrations in the western, northern, and eastern perimeter of the Gulf of Maine, the Bay of Fundy and along the southern Nova Scotian coast.

In the fall, minke whales should occur in the Northeast OPAREAs in lower numbers (Waring et al., 2007), primarily over the continental shelf and slope in waters from the Bay of Fundy and the Scotian Shelf to Georges Bank.

GOMEX

There are only confirmed stranding records available to indicate minke whale occurrence in the GOMEX; these are mostly around the Florida Keys (Jefferson and Schiro, 1997; Würsig et al., 2000). Based on their known habitat preferences, minke whales might occur anywhere from nearshore waters (but not up to the shoreline) out into deeper waters in the eastern Gulf but would be considered extralimital to the western Gulf. Minke whales are not expected in the eastern Gulf during the summer, when these whales should occur further north on feeding grounds. Due to the timing of the strandings, these individuals may represent strays moving into the Gulf during their migrations (Würsig et al., 2000; Jefferson, 2006), or the normal migratory route of the species (which appears dispersed at best) might extend into the Florida Strait (Jefferson, 2006). Given the recent lack of records, the former hypothesis may be more accurate (Jefferson, 2006).

3.6.1.1.4 Bryde's Whale (*Balaenoptera edeni*)

Description – Bryde's whales can be easily confused with sei whales. Bryde's whales usually have three prominent ridges on the rostrum (other rorquals generally have only one) (Jefferson et al., 1993). The Bryde's whale's dorsal fin is tall and falcate and generally rises abruptly out of the back. Adults can be up to 16 m (51 ft) in length (Jefferson et al., 1993).

The nomenclature for Bryde's whale is unresolved (Jefferson et al., 2008). In the past, medium-size members of the Balaenopteridae were classified as either sei whales (B. borealis) or Bryde's whales (B. edeni). However, morphological and genetic analyses indicate that there are three species of rorquals that formerly were classified broadly as Bryde's whales (Sasaki et al., 2006). Two of these, B. edeni and B. brydei, have been in contention for nearly a century (Sasaki et al., 2006); currently, they are both classified as "Bryde's whales (B. brydei/edeni)" while the nomenclature remains uncertain (Jefferson et al., 2008). The third species, Omura's whale (B. omurai), was described in 2003; prior to that time, it was described by the term "pygmy Bryde's whale" and classified as B. edeni (Sasaki et al., 2006).

Status – The only currently available abundance information for Bryde's whales is for the northern GOMEX. The best estimate of abundance for the Bryde's whale in the northern GOMEX is 15 individuals (Waring et al., 2008). It has been suggested that the Bryde's whales found in the GOMEX may represent a resident stock (Schmidly, 1981), but there is no information on stock differentiation (Waring et al., 2008). The NOAA Stock Assessment Report provisionally considers the GOMEX population a separate stock from the Atlantic Ocean stock(s) (Waring et al., 2008).

Diving Behavior – Bryde's whales are lunge-feeders, feeding on schooling fish and krill (Nemoto and Kawamura, 1977; Siciliano et al., 2004; Anderson, 2005). Cummings (1985) reported that Bryde's whales may dive as long as 20 min.

Acoustics and Hearing **–** Bryde's whales produce low frequency tonal and swept calls similar to those of other rorquals (Oleson et al., 2003). Calls vary regionally, yet all but one of the call types have a fundamental frequency below 60 Hz. They last from one-quarter of a second to several seconds and are produced in extended sequences (Oleson et al., 2003). Heimlich et al. (2005) recently described five tone types. These include two types of alternating tonal "phrases," a wideband "burst" followed by a tone that occurred in either lower (19 to 30 Hz) or higher (42 Hz) frequencies depending on the area, and an "harmonic tone phrase" with a fundamental frequency of 26 Hz. No vocalization exceeded 80 Hz. While no data on hearing ability for this species are available, Ketten (1997) hypothesized that mysticetes have acute infrasonic hearing.

Distribution **–** Bryde's whales are found in subtropical and tropical waters and generally do not range north of 40° in the Northern Hemisphere or south of 40° in the Southern Hemisphere (Cummings, 1985). In the Atlantic, Bryde's whales are distributed in the GOMEX and Caribbean Sea south to Cabo Frio, Brazil (Cummings, 1985; Mullin et al., 1994b). Most sightings in the GOMEX have been made in the DeSoto Canyon region and off western Florida (Davis et al., 2000b). Mead (1977) speculated that the GOMEX represents at least a portion of the range of a dispersed, resident population of Bryde's whale. There is a known concentration of this species in Venezuelan waters (Notarbartolo di Sciara, 1982). There are occasional reported sightings of this species in the rest of the Caribbean (Erdman, 1970; Mignucci-Giannoni, 1989,1996). Long migrations are not typical of Bryde's whales although limited shifts in distribution toward and away from the equator in winter and summer, respectively, have been observed (Cummings, 1985).

Atlantic Ocean, Offshore of the Southeastern United States

The Bryde's whale is difficult to differentiate from the sei whale, and there are no confirmed sightings for this species in the southeastern Atlantic Coast OPAREAs. The Bryde's whale is a tropical species and is, therefore, not expected to occur in the VACAPES or CHPT OPAREAs during any season. There is only one record of this species near the VACAPES OPAREA—a stranding of an immature individual in the winter of 1927 within the Chesapeake Bay. This record is considered extralimital. There are no confirmed sightings of Bryde's whale in the JAX/CHASN OPAREA, although strandings have occurred throughout the year. Bryde's whales could occur in any season from the shore continuing beyond the eastern boundary of the JAX/CHASN OPAREA, but are expected to be unlikely.

Atlantic Ocean, Offshore of the Northeastern United States

The Bryde's whale is a tropical species and is, therefore, not expected to occur in the Northeastern OPAREAs during any season.

GOMEX

Bryde's whales are not often sighted in the GOMEX, though they are observed more frequently than any other species of baleen whale in this region. Sightings have primarily been recorded in the region of the DeSoto Canyon and over the Florida Escarpment, near the 100-m (328-ft) isobath (Mullin et al., 1994b; Davis and Fargion, 1996a; Davis et al., 2000b). This species may occur in the area during any season (Würsig et al., 2000).

During the winter, the greatest likelihood for encountering Bryde's whales is over the Florida Escarpment. In the springtime, Bryde's whales are predicted to occur in the area of the shelf break in a region that includes DeSoto Canyon and part of the Florida Escarpment. The highest Bryde's whale concentrations are thought to be discrete areas in the DeSoto Canyon and over the Florida Escarpment. In the summer, the greatest likelihood for encountering Bryde's whales is in a small region over the Florida Escarpment. During the fall, there are few stranding records which reveal that the species is occasionally present. Weather conditions (i.e., inclement weather increasing) could make sighting this species during this time of the year difficult and could explain why there are no recorded sightings.

3.6.1.1.5 Sei Whale (*Balaenoptera borealis*)

Description – Adult sei whales are up to 18 m (59 ft) in length and are mostly dark gray in color with a lighter belly, often with mottling on the back (Jefferson et al., 1993). There is a single prominent ridge on the rostrum and a slightly arched rostrum with a downturned tip (Jefferson et al., 1993). The dorsal fin is prominent and very falcate. Sei whales are similar in appearance to Bryde's whales, and it is difficult to differentiate them at sea and, in some cases, on the beach (Mead, 1977).

Status – Sei whales are listed as endangered under the ESA. The International Whaling Commission recognizes three sei whale stocks in the North Atlantic: Nova Scotia, Iceland-Denmark Strait, and Northeast Atlantic (Perry et al., 1999). The Nova Scotia Stock occurs in U.S. Atlantic waters and has an abundance estimate of 207 individuals (Waring et al., 2008). There is no designated critical habitat for this species.

The taxonomy of the baleen whale group formerly known as sei and Bryde's whales is currently confused and highly controversial. It clearly consists of three or more species; however, the final determination awaits additional studies. Reeves et al. (2004) provides a recent review; see the Bryde's whale species account above for further explanation.

Diving Behavior – There are no reported diving depths or durations for Sei whales.

Acoustics and Hearing – Sei whale vocalizations were recorded only on a few occasions. Recordings from the North Atlantic consisted of paired sequences (0.5 to 0.8 sec, separated by 0.4 to 1.0 sec) of 10 to 20 short (4 milliseconds [msec]) frequency-modulated (FM) sweeps between 1.5 and 3.5 kHz; source level was not known (Thomson and Richardson, 1995). These mid-frequency calls are distinctly different from low-frequency tonal and frequency swept calls recently recorded in the Antarctic; the average duration of the tonal calls was 0.45 ± 0.3 sec, with an average frequency of 433 ± 192 Hz and a maximum source level of 156 ± 3.6 dB re 1 µPa-m (McDonald et al., 2005). During winter months off Hawaii, Rankin and Barlow (2007) recorded downsweep calls exhibiting two distinct frequency ranges that were attributed to sei whales: the frequency ranges were from 100 to 44 Hz and from 39 to 21 Hz with the former range usually shorter in duration. These calls were similar to fin whale downsweeps and potential functional differences in call use between the two species have not yet been determined. Baumgartner et al. (2008) documented a down sweep call attributed to sei whales in the Great South Channel of the northwest Atlantic which are similar to the frequency-modulated (100 Hz to 44 Hz) calls recorded by Ranken and Barlow (2007) from sei whales in the Pacific Ocean. In the Atlantic, these calls ranged from 82.3 Hz to 34.0 Hz with a duration of approximately 1.38 s (Baumgartner et al., 2008). Calls were heard as single calls primarily but some double or triple calls were heard as well (Baumgartner et al., 2008). While no data on hearing ability for this species are available, Ketten (1997) hypothesized that mysticetes have acute infrasonic hearing.

Distribution **–** Sei whales have a worldwide distribution but are found primarily in cold temperate to subpolar latitudes rather than in the tropics or near the poles (Horwood, 1987). Sei whales are also known for occasional irruptive occurrences in areas followed by disappearances for sometimes decades (Horwood, 1987; Schilling et al., 1992; Clapham et al., 1997; Gregr et al., 2005).

Sei whales spend the summer months feeding in subpolar higher latitudes and return to lower latitudes to calve in the winter. There is some evidence from whaling catch data of differential migration patterns by reproductive class, with females arriving at and departing from feeding areas earlier than males (Horwood, 1987; Perry et al., 1999; Gregr et al., 2000). For the most part, the location of winter breeding areas remains a mystery (Rice, 1998; Perry et al., 1999), but the winter range of most rorquals is hypothesized to be in offshore waters (Kellogg, 1928; Gaskin, 1982).

In the western North Atlantic Ocean, sei whales occur primarily from Georges Bank north to Davis Strait (northeast Canada, between Greenland and Baffin Island) (Perry et al., 1999). Sei whales are not known to be common in most U.S. Atlantic waters (NMFS, 1998a). Peak abundance in U.S. waters occurs from winter through spring (mid-March through mid-June), primarily around the edges of Georges Bank (CETAP, 1982; Stimpert et al., 2003). The distribution of the Nova Scotia stock might extend along the U.S. coast at least to North Carolina (NMFS, 1998a). The hypothesis is that the Nova Scotia stock moves from spring feeding grounds on or near Georges Bank, to the Scotian Shelf in June and July, eastward to perhaps Newfoundland and the Grand Banks in late summer, then back to the Scotian Shelf in fall, and offshore and south in winter (Mitchell and Chapman, 1977).

As noted by Reeves et al. (1999c), reports in the literature from any time before the mid-1970s are suspect because of the frequent failure to distinguish sei from Bryde’s whales, particularly in tropical to warm-temperate waters where Bryde’s whales are generally more common than sei whales.

Atlantic Ocean, Offshore of the Southeastern United States

Sei whales are not common in U.S. Atlantic waters. Peak abundance in U.S. waters occurs in spring, primarily around the edges of Georges Bank. The distribution of the Nova Scotia stock may extend south along the U.S. coast to at least North Carolina.

Sightings and strandings have been documented in and around the VACAPES OPAREA throughout the year in continental shelf and slope waters, as well as further offshore.

There are several sei whale records for the North Carolina area. This species is probably a relatively common migrant there (Lee and Socci, 1989). This whale is difficult to distinguish from Bryde’s whale at sea and is frequently grouped with Bryde’s whale in the sighting data.

There is only one recorded sighting of a sei whale in the CHPT OPAREA. Two other individuals were recorded during the Oregon II marine mammal survey near the Onslow Bay area in January 1992, but they were not positively identified as either sei or Bryde's whales. January through April is the time of year when this species is most likely to be present in the OPAREA.

There are only two documented strandings. These include a fall stranding and a spring stranding in the JAX/CHASN OPAREA. In the summer, sei whales are expected to be in northerly feeding grounds (e.g., the Grand Banks) or in offshore waters. During the fall, winter, and spring, the likelihood of encountering this species is not known.

Atlantic Ocean, Offshore of the Northeastern United States

Sei whales occur primarily in the northern region of the Northeast in continental shelf and slope waters, and winter has the lowest reported occurrence of sei whales.

In the spring, sei whales occur primarily over the continental shelf and slope, in waters from the Bay of Fundy to the northern region of the Narragansett Bay OPAREA. The greatest concentrations of sei whales in spring may be found along the northern flank and eastern tip of Georges Bank. Occurrence records also indicated the sei whales may occur along the shelf break on southern Georges Bank. This is consistent with what is known about sei whale distribution in the western North Atlantic Ocean (CETAP, 1982; Stimpert et al., 2003).

In the summer, the general occurrence of sei whales extends from the Bay of Fundy and the Scotian Shelf to the northern region of Narragansett Bay OPAREA. Occurrence records indicate that sei whales are primarily distributed in the Bay of Fundy, Roseway Basin, and Northeast Channel. Occurrences in these areas of complex bottom topography that may concentrate prey species with the known habitat associations of the sei whale (Nishiwaki, 1966; Kenney and Winn, 1987; Schilling et al., 1992; Best and Lockyer, 2002).

During the fall, sei whales may be found in limited areas of the continental shelf waters, in the Northeast Channel and in the western Gulf of Maine, which are both located in the Boston OPAREA.

GOMEX

The sei whale is represented by only three reliable records in the northern Gulf: two strandings near Louisiana and one stranding in the Florida Panhandle (Jefferson and Schiro, 1997). Based on the scarcity of records for this species in the Gulf, the sei whale is not expected to occur in the GOMEX. Any sightings are considered extralimital for this species as sei whales are uncommon in most tropical regions (Jefferson and Schiro, 1997).

3.6.1.1.6 Fin Whale (*Balaenoptera physalus*)

Description **–** The fin whale is the second-largest whale species, with adults reaching 24 m (79 ft) in length (Jefferson et al., 1993). Fin whales have a very sleek body with a pale, V-shaped chevron on the back just behind the head. The dorsal fin is prominent but with a shallow leading edge and is set back two-thirds of the body length from the head (Jefferson et al., 1993). The head color is asymmetrical, with a lower jaw that is white on the right and black or dark gray on the left. Fin and sei whales are very similar in appearance and size which has resulted in confusion about the distribution of both species (NMFS, 1998a).

Status **–** Fin whales are classified as endangered under the ESA (NMFS, 2006j). The NOAA Stock Assessment Report estimates that there are 2,269 individual fin whales in the U.S. Atlantic waters (Waring et al., 2008); this is likely to be larger than the estimate because the habitat of the stock is not well known, and there are uncertainties with regard to population structure and movements of whales between surveyed and unsurveyed areas (Waring et al., 2008). Incorporation of a dive correction factor brings the estimate to 5,000 to 6,000 fin whales in the waters of the U.S. Atlantic (CETAP, 1982; Kenney et al., 1997). No critical habitat is designated for this species.

Diving Behavior – Fin whale dives are typically 5 to 15 minutes long and separated by sequences of four to five blows at 10 to 20 sec intervals (CETAP, 1982; Stone et al., 1992; Lafortuna et al., 2003). Kopelman and Sadove (1995) found significant differences in blow intervals, dive times, and blows per hour between surface-feeding and non-surface-feeding fin whales. Croll et al. (2001) determined that fin whales off the Pacific coast dived to a mean of 97.9 m (321.2 ft) (standard deviation [S.D.] of ± 32.6 m [106.9 ft]) with a duration of 6.3 min (S.D. of 1.53 min) when foraging and to 59.3 m (194.6 ft) (S.D. of ± 29.67 m [97.34 ft]) with a duration of 4.2 min (S.D.of ± 1.67 min) when not foraging. Panigada et al. (1999) reported fin whale dives exceeding 150 m (492 ft) and coinciding with the diel migration of krill.

Acoustics and Hearing **–** Fin and blue whales produce calls with the lowest frequency and highest source levels of all cetaceans. Infrasonic, patterned sounds have been documented for fin whales (Watkins et al., 1987; Clark and Fristrup, 1997; McDonald and Fox, 1999). Fin whales produce a variety of sounds with a frequency range up to 750 Hz. The long, patterned 15 to 30 Hz vocal sequence is most typically recorded; only males are known to produce these (Croll et al., 2002). The most typical fin whale sound is a 20 Hz call (Watkins et al., 1987). These signals, or calls, consist of one second pulses (in a frequency-modulated sweep from about 23 to 18 Hz) that are repeated regular intervals (Watkins et al., 1987). These “20 Hz signals” can reach source levels ranging from 184 to 186 dB re 1 μPa-m, with a maximum of 200 dB re 1 μPa-m (Watkins et al., 1987; Thomson and Richardson, 1995; Charif et al., 2002).. Croll et al. (2002) recently suggested that these long, patterned vocalizations might function as male breeding displays, much like those that male humpback whales sing. The source depth, or depth of calling fin whales, has been reported to be about 50 m (164 ft) (Watkins et al., 1987). While no data on hearing ability for this species are available, Ketten (1997) hypothesized that mysticetes have acute infrasonic hearing.

Distribution – Fin whales are broadly distributed throughout the world’s oceans, usually in temperate to polar latitudes and less commonly in the tropics (Reeves et al., 2002a). In general, fin whales are more common north of about 30ºN than they are in tropical zones (NMFS, 1998a). The overall range of fin whales in the North Atlantic extends from the GOMEX/Caribbean and Mediterranean north to Greenland, Iceland, and Norway (Gambell, 1985; NMFS, 1998a). In the western North Atlantic, the fin whale is the most commonly sighted large whale in continental shelf waters from the mid-Atlantic coast of the United States to eastern Canada (CETAP, 1982;

Hain et al., 1992; Waring et al., 2008). Fin whales are the dominant large cetacean species in all seasons in the North Atlantic and have the largest standing stock and food requirements (Hain et al., 1992; Kenney et al., 1997). The fin whale is also the most common whale species acoustically detected with Navy deepwater hydrophone arrays in the North Atlantic (Clark, 1995).

Fin whales are believed to follow the typical baleen whale migratory pattern, with a population shift north into summer feeding grounds and south for the winter. However, the location and extent of the wintering grounds are poorly known (Aguilar, 2002). Peak acoustic detections of fin whales occurred in winter throughout the deep water of the North Atlantic, supporting the widely held hypothesis about their migration. A definite southward movement of the species was detected in the fall with a northward shift in spring; the endpoints of most of the migration routes in the northwestern Atlantic were areas around Newfoundland and Labrador to the north and Bermuda through the West Indies to the south (Clark, 1995). Migration routes are otherwise unknown.

Fin whales are not completely absent from northeastern U.S. continental shelf waters in winter, indicating that not all members of the population conduct a full seasonal migration. This is the most likely large whale species to be sighted off the eastern U.S. coast in winter. Perhaps a fifth to a quarter of the spring/summer peak population remains in this area year-round (CETAP, 1982; Hain et al., 1992).

Atlantic Ocean, Offshore of the Southeastern United States

Fin whales follow the typical baleen whale migratory pattern of feeding at the high latitudes in summer and fasting at low latitudes in winter. It is thought that fin whales migrate north nearshore along the coast during spring and south offshore during winter. Fin whales are common in waters of the U. S. Atlantic, principally from Cape Hatteras northward (Waring et al., 2008). Not all individuals in the population make dedicated annual migrations as was previously thought (Gambell, 1985; Clark and Gagnon, 1997; Waring et al., 2008). There is evidence that a sizeable segment of the population remains at high latitudes throughout the year (Clark and Gagnon, 1997; Watkins et al., 2000).

Fin whales may occur in the VACAPES OPAREA year-round. Sighting data shows that these whales are distributed over the continental shelf and into waters over the continental slope, although the majority of sightings occurred on the continental shelf. Acoustic data indicate there is a substantial deep-ocean component to fin whale distribution (Clark, 1995; Waring et al., 2008).

During the winter, the fin whale may occur in the entire CHPT OPAREA. During the spring and fall, they should occur north of the CHPT OPAREA and during summer, it is expected that fin whales would be on their feeding grounds further north off the northeastern U.S. coast.

During winter, the fin whale may be found in the JAX/CHASN OPAREA. Since fin whales are expected to be on their feeding grounds at higher latitudes off the northeastern U.S. coast during the summer, and migrating to/from the feeding grounds during spring and fall this species is not expected to occur in the JAX/CHASN OPAREA during those seasons.

Atlantic Ocean, Offshore of the Northeastern United States

Fin whales occur year round along the eastern seaboard of the northeast United States in continental shelf and rise waters. During winter, the general distribution of whales seems to shift towards the southern region of the Northeast OPAREAs.

In winter, fin whales are the most common large whale species occurring in U.S. Atlantic continental shelf waters (Mitchell et al., 2002). Greater occurrences of fin whales may be found in Georges Basin, southwestern region of the Narragansett Bay and Atlantic City OPAREAs.

During the spring, fin whales primarily occur on the continental shelf and slope, in waters extending from the Bay of Fundy and the Scotian Shelf south to the VACAPES OPAREA. Fin whales may occur in greater numbers along the perimeter of the Gulf of Maine and on the eastern edge of the OPAREA, with the greatest occurrences found near the southern flank of Georges Bank, just east of Narragansett Bay OPAREA. An important habitat for fin whales is located in the western Gulf of Maine, including Jeffreys Ledge and Stellwagen Bank, to the Great South Channel, in waters with a bottom depth of approximately 90 m (295 ft) (Hain et al., 1992).

In the summer, fin whales generally occur from the Bay of Fundy and the Scotian Shelf south to the VACAPES OPAREA. Fin whales may occur in greater numbers in the Bay of Fundy, east of Crowell Basin, the waters over Browns Bank and the southern flank of Georges Bank, and the western region of the Gulf of Maine. Most fin whale sightings occur during July to August in the Gulf of Maine (Agler et al., 1993).

In the fall, fin whales may occur primarily over the continental shelf and slope, in waters from the Bay of Fundy and the Scotian Shelf to the southern extent of the Northeast OPAREAs. Fin whales may occur in greater concentrations in the Bay of Fundy and the Great South Channel.

GOMEX

There are only four recorded strandings (Jefferson and Schiro, 1997) and two confirmed sightings of fin whales in the GOMEX (Jefferson and Schiro, 1997). All other sightings records for the fin whale in the GOMEX are not verified.

Jefferson and Schiro (1997) suggested that the GOMEX might represent a part of the range of a low-latitude fin whale population in the northwestern Atlantic or that possibly a small relict population is resident in the Gulf. It is more likely that the occurrences of this species in the Gulf might be extralimital and that these fin whale individuals are simply accidental occurrences (Jefferson and Schiro, 1997; Würsig et al., 2000).

3.6.1.1.7 Blue Whale (*Balaenoptera musculus*)

Description **–** Blue whales are the largest living animals. Blue whale adults in the northern hemisphere reach 23 to 28 m (75 to 92 ft) in length (Jefferson et al., 1993). The rostrum of a blue whale is broad and U-shaped, with a single prominent ridge down the center (Jefferson et al., 1993). The tiny dorsal fin is set far back on the body and appears well after the blowholes when the whale surfaces (Reeves et al., 2002b). This species is blue-gray with light (or sometimes dark) mottling.

Status **–** Blue whales are classified as endangered under the ESA. The blue whale was severely depleted by commercial whaling in the twentieth century (NMFS, 1998b). At least two discrete populations are found in the North Atlantic. One ranges from West Greenland to New England and is centered in eastern Canadian waters; the other is centered in Icelandic waters and extends south to northwest Africa (Sears et al., 2005). There are no current estimates of abundance for the North Atlantic blue whale. However, the photo-identified individuals from the Gulf of St. Lawrence area are considered to be a minimum population estimate for the western North Atlantic stock (Waring et al., 2002); there are nearly 400 individuals based on research efforts by Sears et al. (2005). There is no designated critical habitat for this species in the North Atlantic.

Diving Behavior – Blue whales spend greater than 94 percent of their time below the water's surface (Lagerquist et al., 2000). Croll et al. (2001) determined that blue whales dived to an average of 140.0 m (459.3 ft) (S.D. of ± 46.01 m [151.95 ft]) and for 7.8 min (S.D. of ± 1.89 min) when foraging and to 67.6 m (221.8 ft) (S.D. of ± 51.46 m [168.83 ft]) and for 4.9 min (S.D. of ± 2.53 min) when not foraging. However, dives deeper than 300 m have been recorded from tagged individuals (Calambokidis et al., 2003).

Acoustics and Hearing – Blue and fin whales produce calls with the lowest frequency and highest source levels of all cetaceans. Sounds are divided into two categories: short-duration or long duration. Blue whale vocalizations are typically long, patterned low-frequency sounds with durations up to 36 sec (Thomson and Richardson, 1995) repeated every 1 to 2 min (Mellinger and Clark, 2003). Their frequency range is 12 to 400 Hz, with dominant energy in the infrasonic range at 12 to 25 Hz (Ketten, 1998; Mellinger and Clark, 2003). These long, patterned, infrasonic call series are sometimes referred to as "songs." The short-duration sounds are transient, frequency-modulated calls having a higher frequency range and shorter duration than song notes and often sweeping down in frequency (Di Iorio et al., 2005; Rankin et al., 2005). Short-duration sounds appear to be common; however, they are underrepresented in the literature (Rankin et al., 2005). These short-duration sounds are less than 5 sec in duration (Di Iorio et al., 2005; Rankin et al., 2005) and are high-intensity, broadband (858±148 Hz) pulses (Di Iorio et al., 2005). Source levels of blue whale vocalizations are up to 188 dB re 1 μPa-m (Ketten, 1998; Moore, 1999; McDonald et al., 2001). During the Magellan II Sea Test (at-sea exercises designed to test systems for antisubmarine warfare) off the coast of California in 1994, blue whale vocalization source levels at 17 Hz were estimated in the range of 195 dB re 1 μPa-m (Aburto et al., 1997). Vocalizations of blue whales appear to vary among geographic areas (Rivers, 1997), with clear differences in call structure suggestive of separate populations for the western and eastern regions of the North Pacific (Stafford et al., 2001). Blue whale sounds in the North Atlantic have been confirmed to have different characteristics (i.e., frequency, duration, and repetition) than those recorded in other parts of the world (Mellinger and Clark, 2003; Berchok et al., 2006). Stafford et al. (2005) recorded the highest calling rates when blue whale prey was closest to the surface during its vertical migration. While no data on hearing ability for this species are available, Ketten (1997) hypothesized that mysticetes have acute infrasonic hearing.

Distribution **–** Blue whales are distributed from the ice edge to the tropics and subtropics in both hemispheres (Rice, 1998). The longest documented migration for this species is between Iceland and Mauritania at an estimated 5,200 km (2,806 NM) (Sears et al., 2005). Stranding and sighting data suggest that the blue whale's original range in the Atlantic extended south to Florida, the GOMEX, the Cape Verde Islands, and the Caribbean Sea (Yochem and Leatherwood, 1985). Blue whales rarely occur in the U.S. Atlantic Exclusive Economic Zone (EEZ) and the Gulf of Maine from August to October, which may represent the limits of their feeding range (CETAP, 1982; Wenzel et al., 1988). Sightings in the Gulf of Maine and U.S. EEZ have been made in late summer and early fall (August and October) (CETAP, 1982; Wenzel et al., 1988). Researchers using the Navy-integrated undersea surveillance system (IUSS) resources detected blue whales throughout the open Atlantic south to at least the Bahamas (Clark, 1995), suggesting that all North Atlantic blue whales may comprise a single stock (NMFS, 1998b).

Atlantic Ocean, Offshore of the Southeastern United States

There is only one record of a blue whale in the VACAPES OPAREA, a sighting made between the 3,000 m (9,840 ft) and 4,000 m (13,120 ft) isobaths. There are no records of the blue whale in the CHPT or CHAS/JAX OPAREAs.

The absence of records of blue whales may indicate that blue whales are often difficult to distinguish from other large baleen whales. This whale is primarily a deep-water species, and the winter range of most large baleen whales is thought to be in offshore waters. Acoustic data support the hypothesis of an offshore wintering habitat (Clark, 1995). The likelihood of encountering this species in the VACAPES, CHPT, and JAX/CHASN OPAREAs is unknown, but believed to be extremely low.

Atlantic Ocean, Offshore of the Northeastern United States

There are a few occurrence records of blue whales scattered throughout the northeast from the Bay of Fundy and the Scotian Shelf to just outside the southern region of the Northeast OPAREAs. It is possible that the northeastern EEZ represents the southern limits of blue whale feeding grounds (CETAP, 1982; Wenzel et al., 1988; Mitchell et al., 2002).

GOMEX

This is one of the rarest cetacean species in the GOMEX (Würsig et al., 2000). There are only two reliable records for blue whales in the GOMEX; both records are strandings (Jefferson and Schiro, 1997). Any records for this species should be considered extralimital in the GOMEX.

3.6.1.2 Odontocetes

The following odontocetes have possible or confirmed occurrence along the East Coast and in the GOMEX.

3.6.1.2.1 Sperm Whale (*Physeter macrocephalus*)

Description **–** The sperm whale is the largest toothed whale species. Adult females can reach 12 m (39 ft) in length, while adult males measure as much as 18 m (59 ft) in length (Jefferson et al., 1993). The head is large (comprising about one-third of the body length) and squarish. The lower jaw is narrow and underslung. The blowhole is located at the front of the head and is offset to the left (Rice, 1989). Sperm whales are brownish gray to black in color with white areas around the mouth and often on the belly. The flippers are relatively short, wide, and paddle-shaped. There is a low rounded dorsal hump and a series of bumps on the dorsal ridge of the tailstock (Rice, 1989). The surface of the body behind the head tends to be wrinkled (Rice, 1989).

Status **–** Sperm whales are classified as endangered under the ESA (NMFS, 2006e), although they are globally not in any immediate danger of extinction. The current best estimate of sperm whale abundance in the western North Atlantic Ocean is 4,804 individuals (Waring et al., 2007). The current best estimate of abundance for sperm whales in the northern GOMEX is 1,665 individuals (Waring et al., 2008). Based on mark-recapture analyses of photo-identified individuals, 398 individuals are suggested to utilize the region south of the Mississippi River Delta between the Mississippi Canyon and DeSoto Canyon along and about the 1,000 m (3,281 ft) isobath (Jochens et al., 2006). NMFS provisionally considers the sperm whale population in the northern GOMEX as a stock distinct from the U.S. Atlantic stock (Waring et al., 2008). Genetic analyses, coda vocalizations, and population structure support this (Jochens et al., 2006). Stock structure for sperm whales in the North Atlantic is not known (Dufault et al., 1999). There is no designated critical habitat for this species.

Diving Behavior – Sperm whales forage during deep dives that routinely exceed a depth of 400 m (1,312 ft) and a duration of 30 min (Watkins et al., 2002). They are capable of diving to depths of over 2,000 m (6,562 ft) with durations of over 60 min (Watkins et al., 1993). Sperm whales spend up to 83 percent of daylight hours underwater (Jaquet et al., 2000; Amano and Yoshioka, 2003). Males do not spend extensive periods of time at the surface (Jaquet et al., 2000). In contrast, females spend prolonged periods of time at the surface (1 to 5 hrs daily) without foraging (Whitehead and Weilgart, 1991; Amano and Yoshioka, 2003). An average dive cycle consists of about a 45 min dive with a 9 min surface interval (Watwood et al., 2006). The average swimming speed is estimated to be 2.5 km/hr (1.3 kn) (Watkins et al., 2002). Dive descents for tagged individuals average 11 min at a rate of 5.5 km/hr (2.95 kn), and ascents average 11.8 min at a rate of 5.5 km/hr (3 kn) (Watkins et al., 2002).

Acoustics and Hearing **–** Sperm whales typically produce short-duration (less than 30 ms), repetitive broadband clicks used for communication and echolocation. These clicks range in frequency from 0.1 to 30 kHz, with dominant frequencies between the 2 to 4 kHz and 10 to 16 kHz ranges (Thomson and Richardson, 1995). When sperm whales are socializing, they tend to repeat series of group-distinctive clicks (codas), which follow a precise rhythm and may last for hours (Watkins and Schevill, 1977). Codas are shared between individuals of a social unit and are considered to be primarily for intragroup communication (Weilgart and Whitehead, 1997; Rendell and Whitehead, 2004). Recent research in the South Pacific suggests that in breeding areas the majority of codas are produced by mature females (Marcoux et al., 2006). Coda repertoires have also been found to vary geographically and are categorized as dialects, similar to those of killer whales (Weilgart and Whitehead, 1997; Pavan et al., 2000). For example, significant differences in coda repertoire have been observed between sperm whales in the Caribbean and those in the Pacific (Weilgart and Whitehead, 1997). While very few codas or coda types have been attributed to male sperm whales, over seven years Frantzis and Alexiadou (2008) documented coda production from 15 sperm whales and determined that male coda production is linked to behavioral context and the presence of conspecifics. Three behavioral contexts were identified for which coda production seemed to send different messages: 1) those related to ascending or descending dive cycles, 2) codas produced while interacting in groups, and 3) those at the surface or as associated with altered dive profiles (Frantzis and Alexiadou, 2008). Twenty five coda types were divided into eight coda families and while the exact messages in the codas remain unknown, correlation with behavioral context of male sperm whale coda use indicates coordinated, acoustic communication among sperm whales.

Furthermore, the clicks of neonatal sperm whales are very different from those of adults. Neonatal clicks are of low directionality, long duration (2 to 12 ms), low frequency (dominant frequencies around 0.5 kHz) with estimated source levels between 140 and 162 dB re 1 μPa-m rms, and are hypothesized to function in communication with adults (Madsen et al., 2003). Source levels from adult sperm whales' highly directional (possible echolocation), short (100 μs) clicks have been estimated up to 236 dB re 1 μPa-m rms (Møhl et al., 2003). Creaks (rapid sets of clicks) are heard most frequently when sperm whales are engaged in foraging behavior in the deepest portion of their dives with intervals between clicks and source levels being altered during these behaviors (Miller et al., 2004; Laplanche et al., 2005). It has been shown that sperm whales may produce clicks during 81 percent of their dive period, specifically 64 percent of the time during their descent phases (Watwood et al., 2006). In addition to producing clicks, sperm whales in some regions like Sri Lanka and the Mediterranean Sea have been recorded making what are called trumpets at the beginning of dives just before commencing click production (Teloni, 2005). The estimated source level of one of these low intensity sounds (trumpets) was estimated to be 172 dB_{pp} re 1 μPa-m (Teloni et al., 2005).

The anatomy of the sperm whale's inner and middle ear indicates an ability to best hear high-frequency to ultrasonic frequency sounds. They may also possess better low-frequency hearing than other odontocetes, although not as low as many baleen whales (Ketten, 1992). The auditory brainstem response (ABR) technique used on a stranded neonatal sperm whale indicated it could hear sounds from 2.5 to 60 kHz with best sensitivity to frequencies between 5 and 20 kHz (Ridgway and Carder, 2001).

Distribution **–** Sperm whales are found from tropical to polar waters in all oceans of the world between approximately 70°N and 70°S (Rice, 1998). Females use a subset of the waters where males are regularly found. Females are normally restricted to areas with SST greater than approximately 15°C, whereas males, and especially the largest males, can be found in waters as far poleward as the pack ice with temperatures close to 0° (Rice, 1989). The thermal limits on female distribution correspond approximately to the 40° parallels (50° in the North Pacific; Whitehead, 2003). Photo-identification data analyzed by Jaquet et al. (2003) revealed that seven female sperm whales moved into the Gulf of California from the Galápagos Islands, traveling up to 3,803 km (2,052 NM); these are among the longest documented movements for female sperm whales.

Sperm whales are the most-frequently sighted large whale seaward of the continental shelf off the eastern United States (CETAP, 1982; Kenney and Winn, 1987; Waring et al., 1993; Waring et al., 2007). In Atlantic EEZ waters, sperm whales appear to have a distinctly seasonal distribution (CETAP, 1982; Scott and Sadove, 1997; Waring et al., 2007). In winter, sperm whales are primarily concentrated east and northeast of Cape Hatteras. However, in spring, the center of concentration shifts northward to off Delaware and Virginia and is generally widespread throughout the central MAB and southern Georges Bank. Summer distribution is similar to spring but also includes the area northeast of Georges Bank and into the Northeast Channel region as well as shelf waters south of New England. Fall sperm whale occurrence is generally south of New England over the continental shelf, with a remaining contingent over the continental shelf break in the MAB. Despite these seasonal shifts in concentration, no movement patterns affect the entire stock (CETAP, 1982). Although concentrations shift depending on the season, sperm whales are generally distributed in Atlantic EEZ waters year-round.

The region of the Mississippi River Delta has been recognized for high densities of sperm whales and appears to represent an important calving and nursery area for these animals (Townsend, 1935; Collum and Fritts, 1985; Mullin et al., 1994b; Würsig et al., 2000; Baumgartner et al., 2001; Davis et al., 2002; Mullin et al., 2004; Jochens et al., 2006). Body sizes for most of the sperm whales seen off the mouth of the Mississippi River range from 7 to 10 m (23 to 33 ft), which is the typical size for females and younger animals (Weller et al., 2000; Jochens et al., 2006). On the basis of photo-identification of sperm whale flukes and acoustic analyses, it is likely that some sperm whales are residents of the GOMEX (Weller et al., 2000; Jochens et al., 2006). Tagging data demonstrated that some individuals spend several months at a time in the Mississippi River Delta and the Mississippi Canyon, while other individuals move to other locations the rest of the year (Jochens et al., 2006). Spatial segregation between the sexes was noted one year by Jochens et al. (2006); females and immatures showed high site fidelity to the region south of the Mississippi River Delta and Mississippi Canyon and in the western Gulf, while males were mainly found in the DeSoto Canyon and along the Florida slope.

Atlantic Ocean, Offshore of the Southeastern United States.

In the VACAPES OPAREA, sperm whales are distributed along the continental shelf edge and over the continental slope. There have also been occasional sightings on the continental shelf. During the winter, spring, and fall, their occurrence in the VACAPES OPAREA is expected in the area of the continental shelf edge between the 200-m (656-ft) and the 4,000-m (13,120-ft) isobaths. In the summer, the highest likelihood of encountering this species, begins at the 200-m (656-ft) isobath and extends past the eastern boundary of the VACAPES OPAREA (DON, 2007a).

In the CHPT OPAREA, sperm whales are most likely to occur in waters seaward of the continental shelf edge (the 200-m [656-ft] isobath) throughout the year. During winter, there is an area of concentrated sperm whale occurrence that extend into the northern portion of the OPAREA between the 200-m (656-ft) and 2,000-m (6,560-ft) isobaths.

In the JAX/CHASN OPAREA, sperm whales are most likely to occur from the vicinity of the continental shelf break continuing beyond the eastern boundary of the OPAREA throughout the year.

Atlantic Ocean, Offshore of the Northeastern United States

Sperm whales may occur year-round throughout the Northeast OPAREAs in continental slope waters extending out to deeper waters of the southern region of the Northeast OPAREAs. Overall, summer seems to have the greatest occurrence of sperm whales.

During the summer months, sperm whales occur primarily in continental slope waters out to deeper waters of the southern region of the Northeast OPAREAs, extending from the Scotian Shelf south to the VACAPES OPAREA. In this season, sperm whales may occur in greatest concentrations in the southwestern regions of Narragansett Bay OPAREA, with the greatest concentrations occurring off the southern flank of Georges Bank.

GOMEX

Worldwide, sperm whales exhibit a strong affinity for deep waters beyond the continental shelf break (Rice, 1989). The recorded observations of sperm whales in the GOMEX support this trend, with sightings consistently recorded in waters beyond the 200-m (656-ft) isobath. Overall, sperm whales may occur year-round in the deepest waters of the northern GOMEX and the outer continental shelf waters in the region off the Mississippi River Delta, which may represent a significant calving and nursery area for the species in the northern GOMEX (Mullin et al., 2004). Sperm whales tend to be observed most often near the 1,000-m (3,281-ft) isobath (Jochens et al., 2006). They have been recorded (visually and acoustically) in sufficient numbers during all seasons to provide additional support to the belief that the GOMEX supports a resident population (Weller et al., 2000; Jochens et al., 2006). There is a consistent aggregation of sperm whales in the southeastern Gulf west of the Dry Tortugas (Mullin and Fulling, 2004). These aggregations are thought to result from primary productivity associated with the Mississippi River plume and periodic formation of the cyclonic Tortugas Gyre near the Dry Tortugas. The Florida Straits represent a probable corridor for movements of individuals between the GOMEX and Caribbean Sea (or even western North Atlantic waters).

In the winter, the occurrence of sperm whales is patchy, with all sighting records located in deep water. Survey effort during this season, especially in the deep waters of the Gulf, is low and may explain the paucity of sighting records. There may be a very small area of high concentration in deep waters over the Rio Grande Slope. Stranding records along western Florida and the Keys support the likelihood of sperm whale occurrence in waters off of Florida during this season.

During spring, there is the greatest intensity and distribution of survey effort which explains the large number of sightings during this time of year. The occurrence of sperm whales during this season is the most spatially extensive in the Gulf, with all sightings recorded in waters beyond the 200-m (656-ft) isobath. Sperm whales may occur in the deepest waters throughout the northern GOMEX and in all OPAREAs.

During summer, sperm whales may occur in the deepest Gulf waters west of the DeSoto Canyon, including the Corpus Christi, New Orleans, and Pensacola OPAREAs. There are stranding records in southern Florida, including the Florida Keys, as well as one sighting near the Florida Straits. Of interest is a report of a sperm whale giving birth on July 15, 2006, 163 km (88 NM) offshore of south Texas (no further details on the exact location were provided) (Christenson, 2006).

In the fall, occurrence records are relatively sparse and patchy in waters seaward of the shelf break. Whether the lower number of sighting records during this season is due to reduced survey effort or the movement of sperm whales out of the Gulf or into more southerly waters cannot be detailed without further seasonal survey effort.

3.6.1.2.2 Pygmy and Dwarf Sperm Whales (*Kogia breviceps* and *Kogia sima*)

Description **–** There are two species of *Kogia*: the pygmy sperm whale and the dwarf sperm whale. Recent genetic evidence suggests that there might be an Atlantic and a Pacific species of dwarf sperm whales; however, more data are needed to make such a determination (Chivers et al., 2005).

Pygmy sperm whales have a shark-like head with a narrow, underslung lower jaw (Jefferson et al., 1993). The flippers are set high on the sides near the head. The small falcate dorsal fin of the pygmy sperm whale is usually set well behind the midpoint of the back (Jefferson et al., 1993). The dwarf sperm whale is similar in appearance to the pygmy sperm whale, but it has a larger dorsal fin that is generally set nearer the middle of the back (Jefferson et al., 1993). The dwarf sperm whale also has a shark-like profile but with a more pointed snout than the pygmy sperm whale. Pygmy and dwarf sperm whales reach body lengths of around 3 and 2.5 m (10 to 8 ft), respectively (Jefferson et al., 2008).

Dwarf and pygmy sperm whales are difficult for the inexperienced observer to distinguish from one another at sea, and sightings of either species are often categorized as *Kogia* spp. The difficulty in identifying pygmy and dwarf sperm whales is exacerbated by their avoidance reaction towards ships and change in behavior towards approaching survey aircraft (Würsig et al., 1998). Based on the cryptic behavior of these species and their small group sizes (much like that of beaked whales), as well as similarity in appearance, it is difficult to identify these whales to species in sightings at sea.

Status **–** There is currently no information to differentiate Atlantic stock(s) (Waring et al., 2007). The best estimate of abundance for both species combined in the western North Atlantic is 395 individuals (Waring et al., 2007). Species-level abundance estimates cannot be calculated due to uncertainty of species identification at sea (Waring et al., 2007).

There is currently no information to differentiate the Northern GOMEX stocks from the Atlantic stock(s) (Waring et al., 2008). The best estimate of abundance for *Kogia* spp. in the GOMEX is 453 individuals (Waring et al., 2008). A separate estimate of abundance for the pygmy sperm whale or the dwarf sperm whale cannot be calculated due to uncertainty of species identification at sea (Waring et al., 2008).

Diving Behavior – Willis and Baird (1998) reported that whales of the genus *Kogia* make dives of up to 25 min. Dive times ranging from 15 to 30 min (with 2 min surface intervals) have been recorded for a dwarf sperm whale in the Gulf of California (Breese and Tershy, 1993). Median dive times of around 8 min are documented for *Kogia* (Barlow et al., 1997). A satellite-tagged pygmy sperm whale released off Florida was found to make long nighttime dives, presumably indicating foraging on squid in the deep scattering layer (DSL) (Scott et al., 2001). Most sightings of *Kogia* are brief; these whales are often difficult to approach and they sometimes actively avoid aircraft and vessels (Würsig et al., 1998).

Acoustics and Hearing – There is little published information on sounds produced by *Kogia* spp, although they are categorized as non-whistling smaller toothed whales. Recently, free-ranging dwarf sperm whales off La Martinique (Lesser Antilles) were recorded producing clicks at 13 to 33 kHz with durations of 0.3 to 0.5 sec (Jérémie et al., 2006). The only sound recordings for the pygmy sperm whale are from two stranded individuals. A stranded individual being prepared for release in the western North Atlantic emitted clicks of narrowband pulses with a mean duration of 119 μsec, interclick intervals between 40 and 70 msec, centroid frequency of 129 kHz (centroid is the frequency which divides the energy in the click into two equal portions), peak frequency of 130 kHz, and apparent peak-peak source level up to 175 dB re 1 μPa-m (Madsen et al., 2005a). Another individual found stranded in Monterey Bay produced echolocation clicks ranging from 60 to 200 kHz, with a dominant frequency of 120 to 130 kHz (Ridgway and Carder, 2001).

No information on hearing is available for the dwarf sperm whale. An ABR study completed on a stranded pygmy sperm whale indicated a hearing range of 90 to 150 kHz (Ridgway and Carder, 2001).

Distribution **–** *Kogia* species apparently have a worldwide distribution in tropical and temperate waters (Rice, 1998). In the western Atlantic Ocean, *Kogia* spp. (specifically, the pygmy sperm whale) are documented as far north as the northern Gulf of St. Lawrence (Measures et al., 2004) and as far south as Colombia (dwarf sperm whale) (Muñoz-Hincapié et al., 1998). *Kogia* spp. generally occur along the continental shelf break and over the continental slope in the GOMEX (Baumgartner et al., 2001).

Atlantic Ocean, Offshore of the Southeastern United States

Western North Atlantic sightings of the physically similar pygmy and dwarf sperm whales occur primarily along the continental shelf and over the deeper waters off the continental shelf. There are limited sighting data for these species in the VACAPES OPAREA, and all recorded sightings are from the summer. The pygmy and dwarf sperm whales may occur in the VACAPES OPAREA during any season.

Pygmy and dwarf sperm whales are generally found along the outside of the continental shelf edge (the 200-m [656-ft] isobath) in warm-temperate to tropical waters in the North Atlantic. In the CHPT and JAX/CHASN OPAREAs, these whales are most likely to occur from the continental shelf edge to beyond the eastern boundary of the OPAREA. The distribution is assumed to be the same for all four seasons.

Atlantic Ocean, Offshore of the Northeastern United States

There is only a single sighting for each of the pygmy and dwarf sperm whales in the Northeast OPAREAs, both of which occurred in the summer when the majority of the remaining *Kogia* spp. sightings also occurred. With one exception, all of the sightings of *Kogia* spp. are located in continental slope and deeper waters from Georges Bank south. A large number of pygmy sperm whale stranding records occur as far north as Cape Cod while one dwarf sperm whale stranding was recorded in southernmost Maine. Based on these limited data, *Kogia* spp., including the dwarf sperm whale, may occur in waters from southern Maine to the deep waters in the southern region of the Northeast OPAREAs. It is likely that the cryptic behavior of this species is responsible for so few sighting records.

GOMEX

Kogia spp. generally occur along the continental shelf break and over the continental slope in the GOMEX (Baumgartner et al., 2001; Fulling and Fertl, 2003).

In the winter, *Kogia* spp. are found throughout the northern Gulf, seaward of the shelf break. This is a time of year that is typically data deficient for deep water cetaceans in the Gulf because there is little survey effort. It is also the time when inclement weather conditions occur, and since *Kogia* spp. are low to the water, they can be difficult to sight in rough seas.

During the spring and summer, *Kogia* spp. may occur throughout most of the deep water sections of the Gulf. There is a concentration of records near the south-central edge of the GOMEX based on sighting records in the spring and two sites of concentrated occurrence records near the south-central edge of the Mexican-U.S. maritime boundary and directly south of Louisiana over the continental slope in the summer.

In the fall, there are sightings within the Mississippi Canyon and DeSoto Canyon regions which indicate that, as expected, this region is important habitat for this species.

3.6.1.2.3 Beaked Whales (various species)

Description – Based upon available data, six beaked whales are known to occur in the western North Atlantic Ocean: Cuvier's beaked whales, northern bottlenose whales, and four members of the genus *Mesoplodon* (True’s, Gervais', Blainville's, and Sowerby's beaked whales), which, with the exception of *Ziphius* and *Hyperoodon*, are nearly indistinguishable at sea (Jefferson et al., 2008). Four have documented occurrence in the GOMEX, including Cuvier's beaked whale and three members of the genus *Mesoplodon* (Gervais', Blainville's, and Sowerby's beaked whales). The Smithsonian Institution has developed an online system to facilitate species-level identification of stranded individuals; it can be accessed at http://vertebrates.si.edu/mammals/beaked_whales/pages/main_menu.htm. They are presented in one summary due to the paucity of biological information available for each species and the difficulty of species-level identifications for *Mesoplodon* species. *Mesoplodon* spp. are also often termed ‘mesoplodonts.’

Cuvier's beaked whales are relatively robust compared to other beaked whale species. Male and female Cuvier's beaked whales may reach 7.5 and 7.0 m (24.6 and 23.0 ft) in length, respectively (Jefferson et al., 1993). This species has a relatively short beak, which along with the curved jaw, resembles a goose beak. The body is spindle shaped, and the dorsal fin and flippers are small which is typical for beaked whales. A useful diagnostic feature is a concavity on the top of the head, which becomes more prominent in older individuals. Cuvier's beaked whales are dark gray to light rusty brown in color, often with lighter color around the head. In adult males, the head and much of the back can be light gray to white in color, and they also often have many light scratches and circular scars on the body (Jefferson et al., 1993).

Northern bottlenose whales are 7 to 9 m (23 to 30 ft) in length with rotund bodies, large bulbous heads, and small, well-defined beaks (Mead, 1989b). These whales range in color from green-brown to gray with lighter gray-white markings on the body and lighter coloring on the lower part of the flanks and ventral surface (Jefferson et al., 1993). Diatoms are known to grow on some individuals, giving them an added brownish appearance. The head and face are gray and may even appear white. White or yellow blemishes or scars can be present, especially in older animals. Only mature males have erupted teeth. There is marked sexual dimorphism in the melon of northern bottlenose whales, which is enlarged, flattened, and squared off in males (Mead, 1989b). Gowans and Rendell (1999) observed head-butting by males and speculated that differences in head shape may be significant in male contests for mates.

All mesoplodonts have a relatively small head, large thorax and abdomen, and short tail. Mesoplodonts all have a pair of throat grooves on the ventral side of the head on the lower jaw. Mesoplodonts are characterized by the presence of a single pair of sexually dimorphic tusks, which erupt only in adult males. MacLeod (2000b) suggested that the variation in tusk position and shape acts as a species recognition signal for these whales.

Blainville's beaked whales are documented to reach a maximum length of around 4.7 m (15.4 ft) (Jefferson et al., 1993). Adults are blue-gray on their dorsal side and white below (Jefferson et al., 1993). The lower jaw of the Blainville's beaked whale is highly arched, and massive flattened tusks extend above the upper jaw in adult males (Jefferson et al., 1993).

Gervais' beaked whale males reach lengths of at least 4.5 m, while females reach at least 5 m (17 ft) (Jefferson et al., 1993). These beaked whales are dark gray dorsally with a light-gray belly. Adult males have one tooth evident per side, one-third of the distance from the snout tip to the corner of the mouth (Jefferson et al., 1993).

Sowerby's beaked whale males and females attain lengths of at least 5.5 and 5.1 m (18.0 and 16.7 ft), respectively (Jefferson et al., 1993). The beak is long and distinct. The melon also has a hump on the top. Two small teeth are evident along the middle of the lower jaw in adult males. Coloration has generally been described as charcoal gray dorsally and lighter below (Jefferson et al., 1993). Gray spotting has been noted on adults, although younger animals may also display a lesser degree of spotting (Jefferson et al., 1993).

True's beaked whales reach lengths of slightly over 5 m (17 ft) and weigh up to 1,400 kg (3,086 lb) (Jefferson et al., 1993). Coloration is generally similar to other mesoplodonts. Newborns are likely between 2.0 and 2.5 m (6.6 and 8.2 ft) long. A pair of teeth is located at the tip of the lower jaw.

Status **–** The total number of Cuvier's beaked whales off the eastern U.S. and Canadian Atlantic coast is unknown, but there have been several estimates of an undifferentiated grouping of beaked whales that includes both *Ziphius* and *Mesoplodon* species; the best estimate of the grouping in the western North Atlantic is 3,513 individuals (Waring et al., 2008). A recent study of global phylogeographic structure of Cuvier's beaked whales suggested that some regions show a high level of differentiation ; however, it was not possible for this study to discern finer-scale population differences within the North Atlantic (Dalebout et al., 2005). Using mark-recapture techniques, 133 northern bottlenose whales have been estimated to utilize the Gully (Nova Scotia) (Gowans et al., 2000). It is not possible to obtain any additional species-specific estimates due to the difficulty of individual identification at sea.

The best estimate of abundance for the Cuvier's beaked whale in the northern GOMEX is 65 individuals (Waring et al., 2008). The best estimate of abundance for *Mesoplodon* spp. in the northern GOMEX is 57 individuals (Waring et al., 2008). It is not possible to obtain species-specific estimates due to the difficulty of identifying specimens at sea. The GOMEX Cuvier's beaked whale and *Mesoplodon* spp. populations are provisionally being considered as separate stocks for management purposes although there is currently no information to differentiate these stocks from the Atlantic Ocean stock(s) (Waring et al., 2008).

Diving Behavior – Dives range from those near the surface where the animals are still visible to long, deep dives. Dive durations for *Mesoplodon* spp. are typically over 20 min (Barlow, 1999; Baird et al., 2005b). Tagged northern bottlenose whales off Nova Scotia were found to dive approximately every 80 min to over 800 m (2,625 ft), with a maximum dive depth of 1,453 m (4,764 ft) for as long as 70 min (Hooker and Baird, 1999). Northern bottlenose whale dives fall into two discrete categories: short-duration (mean of 11.7 min), shallow dives and long-duration (mean of 36.98 min), deep dives (Hooker and Baird, 1999). Tagged Cuvier's beaked whale dive durations as long as 87 min and dive depths of up to 1,990 m (6,529 ft) have been recorded (Baird et al., 2004, 2005b). Tagged Blainville's beaked whale dives have been recorded to 1,408 m (4,619 ft) and lasting as long as 54 min (Baird et al., 2005b). Baird et al. (2005b) reported that several aspects of diving were similar between Cuvier's and Blainville's beaked whales: 1) both dove for 48 to 68 minutes to depths greater than 800 m (2,625 ft), with one long dive occurring on average every two hours; 2) ascent rates for long/deep dives were substantially slower than descent rates, while during shorter dives there were no consistent differences; and 3) both spent prolonged periods of time (66 to 155 min) in the upper 50 m (164 ft) of the water column. Both species make a series of shallow dives after a deep foraging dive to recover from oxygen debt; average intervals between foraging dives have been recorded as 63 min for Cuvier's beaked whales and 92 min for Blainville's beaked whales (Tyack et al., 2006).

Acoustics and Hearing – Sounds recorded from beaked whales are divided into two categories: whistles and pulsed sounds (clicks); whistles likely serve a communicative function and pulsed sounds are important in foraging and/or navigation (Johnson et al., 2004; Madsen et al., 2005b; MacLeod and D'Amico, 2006; Tyack et al., 2006). Whistle frequencies are about 2 to 12 kHz, while pulsed sounds range in frequency from 300 Hz to 135 kHz; however, as noted by MacLeod and D'Amico (2006), higher frequencies may not be recorded due to equipment limitations.

There is some specific information on the sound production capability of several of the beaked whale species. Whistles recorded from free-ranging Cuvier's beaked whales off Greece ranged in frequency from 8 to 12 kHz, with an upsweep of about 1 sec (Manghi et al., 1999), while pulsed sounds had a narrow peak frequency of 13 to 17 kHz, lasting 15 to 44 sec in duration (Frantzis et al., 2002). Short whistles and chirps from a stranded subadult Blainville's beaked whale ranged in frequency from slightly less than 1 to almost 6 kHz (Caldwell and Caldwell, 1971a). Recent studies incorporating DTAGs (miniature sound and orientation recording tag) attached to Blainville's beaked whales in the Canary Islands and Cuvier's beaked whales in the Ligurian Sea recorded high-frequency echolocation clicks (duration: 175 μs for Blainville's and 200 to 250 μs for Cuvier's) with dominant frequency ranges from about 20 to over 40 kHz (limit of recording system was 48 kHz) and only at depths greater than 200 m (656 ft) (Johnson et al., 2004; Madsen et al., 2005b; Zimmer et al., 2005; Tyack et al., 2006). Mid-frequency sounds including a frequency-modulated pure tone, and three FM and AM pulsed sounds (between 6 and 16 kHz) were attributed to three cow/calf pairs of Blainville's beaked whales during shipboard visual/acoustic surveys near the Hawaiian islands (Rankin and Barlow, 2007). After these calls were recorded, the whales dove and were not re-sighted. Rankin and Barlow (2007) suggest similarity of these FM sounds to those produced by Baird's beaked whales. The source level of the Blainville's beaked whales' clicks were estimated to range from 200 to 220 dB re 1 μPa-m peak-to-peak (Johnson et al., 2004), while they were 214 dB re 1 μPa-m peak-to-peak for the Cuvier's beaked whale (Zimmer et al., 2005).

Northern bottlenose whale sounds recorded by Hooker and Whitehead (2002) were predominantly clicks, with two major types of click series. Loud clicks were produced by whales socializing at the surface and were rapid with short and variable interclick intervals. The frequency spectrum was often multimodal, and peak frequencies ranged between 2 and 22 kHz (mean of 11 kHz). Clicks received at low amplitude (produced by distant whales, presumably foraging at depth) were generally unimodal frequency spectra with a mean peak frequency of 24 kHz and a 3 dB bandwidth of 4 kHz. Winn et al. (1970) recorded sounds from northern bottlenose whales that were not only comprised of clicks but also whistles that they attributed to northern bottlenose whales. Hooker and Whitehead (2002) noted that it was more likely that long-finned pilot whales (Globicephala melas) had produced the whistles, although they also noted that more recordings from this species while no other animals are around are needed to confirm whether or not the species actually produces whistles or not.

From anatomical examination of their ears, it is presumed that beaked whales are predominantly adapted to best hear ultrasonic frequencies (MacLeod, 1999; Ketten, 2000). Beaked whales have well-developed semi-circular canals (typically for vestibular function but may function differently in beaked whales) compared to other cetacean species, and they may be more sensitive than other cetaceans to low-frequency sounds (MacLeod, 1999; Ketten, 2000). Ketten (2000) remarked on how beaked whale ears (computerized tomography (CT) scans of Cuvier's, Blainville's, Sowerby's, and Gervais' beaked whale heads) have anomalously well-developed vestibular elements and heavily reinforced (large bore, strutted) Eustachian tubes and noted that they may impart special resonances and acoustic sensitivities. The only direct measure of beaked whale hearing is from a stranded juvenile Gervais' beaked whale using auditory evoked potential techniques (Cook et al., 2006). The hearing range was 5 to 80 kHz, with greatest sensitivity at 40 and 80 kHz (Cook et al., 2006).

Distribution **–** Cuvier's beaked whales are the most widely distributed of the beaked whales and are present in most regions of all major oceans (Heyning, 1989; MacLeod et al., 2006). This species occupies almost all temperate, subtropical, and tropical waters, as well as subpolar and even polar waters in some areas (MacLeod et al., 2006).

Northern bottlenose whales are restricted to northern latitudes of the North Atlantic (Mead, 1989). This species is routinely found in the Gully, a submarine canyon off the coast of Nova Scotia, near the southern and western limits of the species' range (Gowans et al., 2000).

The ranges of most mesoplodonts are poorly known. In the western North Atlantic and GOMEX, these animals are known mostly from strandings (Mead, 1989a; MacLeod, 2000a; MacLeod et al., 2006). Blainville's beaked whales are thought to have a continuous distribution throughout tropical, subtropical, and warm-temperate waters of the world's oceans; they occasionally occur in cold-temperate areas (MacLeod et al., 2006). The Gervais' beaked whale is restricted to warm-temperate and tropical Atlantic waters with records throughout the Caribbean Sea (MacLeod et al., 2006). The Gervais' beaked whale is the most frequently stranded beaked whale in the GOMEX (Würsig et al., 2000). The Sowerby's beaked whale is endemic to the North Atlantic; this is considered to be more of a temperate species (MacLeod et al., 2006). The stranding on the Gulf coast of Florida is considered to be extralimital (Jefferson and Schiro, 1997; MacLeod et al., 2006). In the western North Atlantic, confirmed strandings of True's beaked whales are recorded from Nova Scotia to Florida and also in Bermuda (MacLeod et al., 2006). There is also a sighting made southeast of Hatteras Inlet, North Carolina (note that the latitude provided by Tove is incorrect) (Tove, 1995).

The continental shelf margins from Cape Hatteras to southern Nova Scotia were recently identified as known key areas for beaked whales in a global review by MacLeod and Mitchell (2006). Macleod and Mitchell (2006) described the northern GOMEX continental shelf margin as "a key area" for beaked whales.

Atlantic Ocean, Offshore of the Southeastern United States

Five species of beaked whales may occur in the waters off the southeastern United States including Cuvier's beaked, Gervais' beaked, Blainville's beaked, and True's beaked. The Sowerby's beaked whale is endemic to the North Atlantic and is considered to be more of a temperate species (MacLeod et al., 2006). The single stranding record from the Gulf coast of Florida is considered to be extralimital (Jefferson and Schiro, 1997; MacLeod et al., 2006). In the VACAPES, CHPT, and JAX/CHASN OPAREAs, beaked whale occurrence is assumed to be the same for all seasons and to primarily occur from the shelf break to the deeper offshore waters.

Atlantic Ocean, Offshore of the Northeastern United States

To determine beaked whale occurrence for the Northeast OPAREAs, information regarding unidentified beaked whales, Blainville's beaked whale, Cuvier's beaked whale, Sowerby's beaked whale, and northern bottlenose whale was pooled. Insufficient data are available for Gervais' beaked whale and True's beaked whale. In general, beaked whales occur in deeper waters off the continental slope. Overall, summer has the highest occurrences of beaked whales. During the wintertime, beaked whales may sporadically occur, extending from the continental slope to those deeper waters over the continental rise, from the southern flank of Georges Bank south to the VACAPES OPAREA. Stranding data suggest that beaked whales may occur as far north as southern Maine.

In the springtime, beaked whales may occur over the continental slope, in waters from the Scotian Shelf, through the southern regions of Narragansett Bay and Atlantic City OPAREAs.

In the summer, the general occurrence of beaked whales extends from waters over the continental slope to those deeper waters over the continental rise, from Browns Bank south to the VACAPES OPAREA. During this season beaked whales may occur in greater concentrations outside the Northeast Channel, along the southern flank of Georges Bank, southeastern region of Narragansett Bay OPAREA, and in the southwestern region of the Northeast OPAREAs.

Lastly, in the fall, beaked whales may sporadically occur, extending from the continental slope to those deeper waters over the continental rise, from outside the Northeast Channel to the southern extent of the Northeast OPAREAs, and the western region of the Narragansett Bay OPAREA, just north of the Hudson Canyon.

GOMEX

Beaked whales are considered to be deep-water species. There are a handful of beaked whale sightings on the continental shelf off Mississippi and Alabama made during the Esher et al. (1992) surveys. Many surveys have taken place on the continental shelf in this region, yet this is the only survey program that recorded beaked whales. Two of the beaked whale sightings reported during the fall in the vicinity of the shelf break are suspect with group sizes of 6 and 10 individuals, respectively. These are larger group sizes than are typically reported. There is also one beaked whale sighting off Mobile Bay, Alabama, in waters with a bottom depth of approximately 30 m (98 ft). This could be a sighting of an individual which may have later stranded.

In the winter, sightings are in waters seaward of the shelf break, particularly over the continental slope. This is a time of year with both decreased survey effort and high sea states that can make sighting cetaceans (especially beaked whales) difficult. Occurrence should be expected in deep waters throughout the entire northern GOMEX.

The spring is the season with the most survey effort; sightings are throughout the deep waters of the northern GOMEX. Beaked whales are anticipated to occur throughout deep waters of the Gulf. The area of greatest concentration may occur over the abyssal plain at the southern edge of the GOMEX. Other patches of high concentrations may occur in waters over the Florida Escarpment and in the region influenced by the Tortugas Gyre.

In the summer, sightings are throughout most of the deep waters of the northern GOMEX. There may be patchy occurrence primarily in the central and eastern GOMEX, particularly in the Mississippi Canyon region and around parts of the Florida Escarpment. The areas of greatest concentration are in waters over the continental slope and abyssal plain south of Louisiana.

Fall is a season with a lesser amount of recorded sightings, likely due to decreased survey effort and high Beaufort sea states that can make sighting cetaceans difficult during this time of year. Occurrence should be expected in deep waters throughout the entire northern GOMEX.

3.6.1.2.4 Rough-toothed Dolphin (*Steno bredanensis*)

Description – This is a relatively robust dolphin with a cone-shaped head; it is the only one with no demarcation between the melon and beak (Jefferson et al., 1993). The “forehead” slopes smoothly from the blowhole onto the long, narrow beak (Reeves et al., 2002b). The rough-toothed dolphin has large flippers that are set far back on the sides and a prominent falcate dorsal fin (Jefferson et al., 1993). The body is dark gray with a prominent narrow dorsal cape that dips slightly down onto the side below the dorsal fin. The lips and much of the lower jaw are white, and many individuals have white scratches and spots on the body from cookie-cutter sharks and other rough-toothed dolphins. The rough-toothed dolphin reaches 2.8 m (9.2 ft) in length (Jefferson et al., 1993).

Status – No abundance estimate is available for rough-toothed dolphins in the western North Atlantic. The best estimate of abundance for rough-toothed dolphins in the northern GOMEX is 2,653 individuals (Waring et al., 2008).

Diving Behavior –Rough-toothed dolphins may stay submerged for up to 15 min (Miyazaki and Perrin, 1994) and are known to dive as deep as 150 m (492 ft) (Manire and Wells, 2005).

Acoustics and Hearing – The rough-toothed dolphin produces a variety of sounds, including broadband echolocation clicks and whistles. Echolocation clicks (duration less than 250 microseconds [µsec]) typically have a frequency range of 0.1 to 200 kHz, with a dominant frequency of 25 kHz. Whistles (duration less than 1 sec) have a wide frequency range of 0.3 to greater than 24 kHz but dominate in the 2 to 14 kHz range (Miyazaki and Perrin, 1994; Yu et al., 2003).

Auditory evoked potential (AEP) measurements were performed on six individuals involved in a mass stranding event on Hutchinson Island, Florida in August 2004 (Cook et al., 2005). The rough-toothed dolphin can detect sounds between 5 and 80 kHz and is most likely capable of detecting frequencies much higher than 80 kHz (Cook et al., 2005).

Distribution – Rough-toothed dolphins are found in tropical to warm-temperate waters globally, rarely ranging north of 40°N or south of 35°S (Miyazaki and Perrin, 1994). Rough-toothed dolphins occur in low densities throughout the eastern tropical Pacific where surface water temperatures are generally above 25°C (77°F) (Perrin and Walker, 1975). This species is not a commonly encountered species in the areas where it is known to occur (Jefferson, 2002b). Not many records for this species exist from the western North Atlantic, but they indicate that this species occurs from Virginia south to Florida, the GOMEX, the West Indies, and along the northeastern coast of South America (Leatherwood et al., 1976; Würsig et al., 2000). Two separate mass strandings of rough-toothed dolphins occurred in the Florida Panhandle during December 1997 and 1998 (Rhinehart et al., 1999). Additionally, a mass stranding of a minimum of 70 individuals occurred off the Florida Keys March 2, 2005 (Banick and Borger, 2005).

Atlantic Ocean, Offshore of the Southeastern United States

Rough-toothed dolphins may occur in waters off the shelf break in the VACAPES, CHPT, and JAX/CHASN OPAREA based on their preference for deep waters. A few strandings and two sightings of rough-toothed dolphins have been recorded in or near the VACAPES OPAREA. It is assumed that rough-toothed dolphin could occur year round. During the winter, the rough-toothed dolphin's is generally expected in warmer waters, so their occurrence may follow the western edge of the Gulf Stream.

Atlantic Ocean, Offshore of the Northeastern United States

The rough-toothed dolphin is extralimital at all times of the year in the Northeast OPAREAs based on the warm-water preference of this species. There are only two confirmed sighting of this species, which occurred in June and September 1979.

GOMEX

Rough-toothed dolphins occur in both oceanic and continental shelf waters in the northern GOMEX (Fulling et al., 2003; Mullin and Fulling, 2004). Rough-toothed dolphins were seen in all seasons during GulfCet aerial surveys of the northern GOMEX between 1992 and 1998 (Hansen et al., 1994; Mullin and Hoggard, 2000).

In the winter, there is only one sighting record available for this species. Two stranded and rehabilitated individuals were released with tags in late March 1998 off Sarasota, Florida and remained in the northeastern GOMEX (Wells et al., 1999). This is a time of year that is typically data deficient for deep-water cetaceans in the Gulf because there is little survey effort. It is also the time when Beaufort sea states are highest which makes detection of species much more difficult (Mullin et al., 2004).

In the spring, rough-toothed dolphins occur in the deeper waters seaward of the shelf break, including over the abyssal plain. Sighting concentrations are predicted to be inshore of the Florida Escarpment and over the continental slope south of Louisiana.

In the summer, the greatest concentration of this species is suggested to be over the abyssal plain. Other concentrations are predicted on the west Florida Shelf and in the Mississippi Canyon region. This is the only time of the year that occurrence is also anticipated in continental shelf waters off southern Texas. The occurrence patterns for this season likely reflect the most realistic picture for the species since both oceanic and shelf occurrences are predicted.

In the fall, two sighting records are available for rough-toothed dolphins during this season. The predicted occurrence is in the Mississippi Canyon region (DON, 2007d). It should be noted that this is a time of year when Beaufort sea states are high which makes detection of species much more difficult (Mullin et al., 2004).

3.6.1.2.5 Bottlenose Dolphin (*Tursiops truncatus*)

Description **–** Bottlenose dolphins are large and robust, varying in color from light gray to charcoal. The common bottlenose dolphin is characterized by a medium-length stocky beak that is clearly distinct from the melon (Jefferson et al., 2008). The dorsal fin is tall and falcate. There are striking regional variations in body size, with adult lengths from 1.9 to 3.8 m (6.2 to 12.5 ft) (Jefferson et al., 1993).

The taxonomy of the genus *Tursiops* has been debated for decades and continues to be contested. Two *Tursiops* species are currently recognized: the common bottlenose dolphin (*Tursiops truncatus*) and Indo-Pacific bottlenose dolphin (*Tursiops aduncus*) (Rice, 1998; Natoli et al., 2004). It is likely that additional species-level taxonomy will be recognized based on future genetic and morphometric analyses (Natoli et al., 2004). Indo-Pacific bottlenose dolphins are found in coastal Indo-Pacific tropics (Curry and Smith, 1997), while all other forms are considered to be common bottlenose dolphins.

Scientists currently recognize several nearshore (coastal) and an offshore morphotype or form of common bottlenose dolphins, which are distinguished by external and cranial morphology, hematology, diet, and parasite load (Duffield et al., 1983; Hersh and Duffield, 1990; Mead and Potter, 1995; Curry and Smith, 1997). There is also a clear genetic distinction between nearshore and offshore bottlenose dolphins worldwide (Curry and Smith, 1997; Hoelzel et al., 1998). It has been suggested that the two forms should be considered different species (Curry and Smith, 1997; Kingston and Rosel, 2004), but no official taxonomic revisions have yet been made.

Status **–** Two forms of common bottlenose dolphins are recognized in the western North Atlantic Ocean: nearshore (coastal) and offshore morphotypes. Each morphotype is referred to as a stock by NMFS. Within the nearshore habitat, NMFS recognizes seven discrete stocks that have distinct spatial and temporal components: Northern Migratory, Southern Migratory, Southern North Carolina, South Carolina, Georgia, Northern Florida, and Central Florida (Waring et al., 2008). Abundance estimates for each respective stock are as follows: 7,489; 10,341; 4,818; 1,952; 5,996; 3,064; and 6,317 (Waring et al., 2008).

Currently, a single western North Atlantic offshore stock is recognized seaward of 34 km (18 NM) from the U.S. coastline (Waring et al., 2008). The best estimate for this stock is 81,588 individuals (Waring et al., 2008).

There is a need for information to accurately identify stocks of bottlenose dolphins in the GOMEX (Hubard and Swartz, 2002; MMC, 2002; Sellas et al., 2005). As noted earlier, offshore and coastal forms are recognized. In the northern GOMEX, there are coastal stocks; a continental shelf stock; an oceanic stock; and bay, sound, and estuarine stocks (Waring et al., 2006). Sellas et al. (2005) reported the first evidence that the coastal stock off west central Florida is genetically separated from the adjacent inshore areas, while Fazioli et al. (2006) recently demonstrated that dolphins found inshore within bays, sounds, and estuaries on the west central Florida coast move into the nearby Gulf waters used by the coastal stocks. Genetic, photo-identification, and tagging data support the concept of relatively discrete bay, sound, and estuarine stocks; these 33 stocks recognized by the NOAA Stock Assessment Report are all thought to occur inshore and are not discussed further here.

There are three coastal stocks in the northern GOMEX that occupy waters from the shore to the 20-m (66-ft) isobath: Eastern Coastal, Northern Coastal, and Western Coastal (Waring et al., 2006). The Western Coastal stock inhabits the nearshore waters from the Texas/Mexico border to the Mississippi River mouth; the best estimate for this stock is 3,449 individuals (Waring et al., 2006). The Northern Coastal stock is defined from the Mississippi River mouth to approximately 84°W; the best estimate is 4,191 dolphins (Waring et al., 2006). The Eastern Coastal stock is defined from 84°W to Key West, Florida; the best estimate is 9,912 individuals (Waring et al., 2006).

The Continental Shelf stock is defined as dolphins inhabiting the waters from the Texas/Mexico border to Key West, Florida between the 20- and 200-m (66- and 656-ft) isobaths (Waring et al., 2006). The best estimate of abundance for this stock is 25,320 bottlenose dolphins (Fulling et al., 2003; Waring et al., 2006). The continental shelf stock probably consists of a mixture of both the coastal and offshore ecotypes.

The Oceanic stock is provisionally defined as bottlenose dolphins inhabiting waters from the 200- m (656-ft) isobath to the seaward extent of the EEZ (Waring et al., 2006). The best estimate of abundance for the bottlenose dolphin in oceanic waters of the northern GOMEX is 2,239 individuals (Mullin and Fulling, 2004; Waring et al., 2006). This stock is believed to consist of the offshore form of bottlenose dolphins described by Hersh and Duffield (1990). Both inshore/coastal stocks and the oceanic stock are separate from the continental shelf stock; however, the continental shelf stock may overlap with coastal stocks and the oceanic stock in some areas and may be genetically indistinguishable from those other stocks (Waring et al., 2006).

Since 1990, there have been ten unusual mortality events (UME) involving bottlenose dolphins in the GOMEX (NOAA and FFWCC, 2004; NMFS, 2008g; Waring et al., 2008). The most recent of these occurred in February and March of 2008, when bottlenose dolphins began stranding along the coast of Texas in relatively large numbers (NMFS, 2008h). During March, 2008, the Texas Marine Mammal Stranding Network responded to 78 bottlenose dolphin strandings (NMFS, 2008h). The investigation into the cause of this UME is ongoing (NMFS, 2008h). Four of the UME's in the GOMEX over the past 18 years have been associated with a biotoxin such as that produced by harmful algal blooms (NMFS, 2008g). The remainder of the UME's (excluding the 2008 event) are of undetermined cause (NMFS, 2008g). NOAA contracted Mote Marine Laboratory to assess the health of bottlenose dolphins (including live captures and tracking) in St. Joseph Bay in the Florida Panhandle during April thru July 2005 (Balmer and Wells, 2006).

Diving Behavior – Dive durations as long as 15 min are recorded for trained individuals (Ridgway et al., 1969a). Typical dives, however, are more shallow and of a much shorter duration. Mean dive durations of Atlantic bottlenose dolphins typically range from 20 to 40 sec at shallow depths (Mate et al., 1995) and can last longer than 5 min during deep offshore dives (Klatsky et al., 2005). Offshore bottlenose dolphins regularly dive to 450 m (1,476 ft) and possibly as deep as 700 m (2,297 ft) (Klatsky et al., 2005). Bottlenose dolphin dive behavior may correlate with diel cycles (Mate et al., 1995; Klatsky et al., 2005); this may be especially true for offshore stocks, which dive deeper and more frequently at night to feed upon the deep scattering layer (Klatsky et al., 2005).

Acoustics and Hearing – Sounds emitted by bottlenose dolphins have been classified into two broad categories: pulsed sounds (including clicks and burst-pulses) and narrow-band continuous sounds (whistles), which usually are frequency modulated. Clicks and whistles have dominant frequency ranges of 110 to 130 kHz and source levels of 218 to 228 dB re 1 μPa-m peak-to-peak

(Au, 1993) and 3.4 to 14.5 kHz and 125 to 173 dB re 1 μPa-m, respectively (Ketten, 1998). Whistles are primarily associated with communication and can serve to identify specific individuals (i.e., signature whistles) (Caldwell and Caldwell, 1965; Janik et al., 2006). Up to 52 percent of whistles produced by bottlenose dolphin groups with mother-calf pairs can be classified as signature whistles (Cook et al., 2004). Sound production is also influenced by group type (single or multiple individuals), habitat, and behavior (Nowacek, 2005). Bray calls (low-frequency vocalizations; majority of energy below 4 kHz), for example, are used when capturing fishes, specifically sea trout (*Salmo trutta*) and Atlantic salmon (*Salmo salar*), in some regions (i.e., Moray Firth, Scotland) (Janik, 2000). Additionally, whistle production has been observed to increase while feeding (Acevedo-Gutiérrez and Stienessen, 2004; Cook et al., 2004). Furthermore, both whistles and clicks have been demonstrated to vary geographically in terms of overall vocal activity, group size, and specific context (e.g., feeding, milling, traveling, and socializing) (Jones and Sayigh, 2002; Zaretsky et al., 2005; Baron, 2006). For example, preliminary research indicates that characteristics of whistles from populations in the northern GOMEX significantly differ (i.e., in frequency and duration) from those in the western North Atlantic (Zaretsky et al., 2005; Baron, 2006).

Bottlenose dolphins can typically hear within a broad frequency range of 0.04 to 160 kHz (Au, 1993; Turl, 1993). Electrophysiological experiments suggest that the bottlenose dolphin brain has a dual analysis system: one specialized for ultrasonic clicks and another for lower-frequency sounds, such as whistles (Ridgway, 2000). Scientists have reported a range of highest sensitivity between 25 and 70 kHz, with peaks in sensitivity at 25 and 50 kHz (Nachtigall et al., 2000). Recent research on the same individuals indicates that auditory thresholds obtained by electrophysiological methods correlate well with those obtained in behavior studies, except at the some lower (10 kHz) and higher (80 and 100 kHz) frequencies (Finneran and Houser, 2006).

Temporary threshold shifts (TTS) in hearing have been experimentally induced in captive bottlenose dolphins using a variety of noises (i.e., broad-band, pulses) (Ridgway et al., 1997; Schlundt et al., 2000; Nachtigall et al., 2003; Finneran et al., 2005; Mooney et al., 2005; Mooney, 2006). For example, TTS has been induced with exposure to a 3 kHz, one-second pulse with sound exposure level (SEL) of 195 dB re 1 μPa^2-s (Finneran et al., 2005), one-second pulses from 3 to 20 kHz at 192 to 201 dB re 1 μPa (Schlundt et al., 2000), and octave band noise (4 to 11 kHz) for 50 minutes at 179 dB re 1 μPa (Nachtigall et al., 2003). Preliminary research indicates that TTS and recovery after noise exposure are frequency dependent and that an inverse relationship exists between exposure time and sound pressure level associated with exposure (Mooney et al., 2005; Mooney, 2006). Observed changes in behavior were induced with an exposure to a 75 kHz one-second pulse at a received level of 178 dB re 1 μPa (Ridgway et al., 1997; Schlundt et al., 2000). Finneran et al. (2005) concluded that a SEL of 195 dB re 1 μPa^2 s is a reasonable threshold for the onset of TTS in bottlenose dolphins exposed to mid-frequency tones.

Distribution – The overall range of the bottlenose dolphin is worldwide in tropical and temperate waters. This species occurs in all three major oceans and many seas. Dolphins of the genus *Tursiops* generally do not range poleward of 45º, except around the United Kingdom and northern Europe (Jefferson et al., 1993). Climate changes can contribute to range extensions as witnessed in association with the 1982/83 El Niño event when the range of some bottlenose dolphins known from the San Diego, California area was extended 600 km (324 NM) northward to Monterey Bay (Wells et al., 1990). Bottlenose dolphins are sighted regularly along the central California coast as far north as San Francisco (Caretta et al., 2007).

In the western North Atlantic, bottlenose dolphins occur as far north as Nova Scotia but are most common in coastal waters from New England to Florida, the GOMEX, the Caribbean, and southward to Venezuela and Brazil (Würsig et al., 2000). Bottlenose dolphins occur seasonally in coastal waters as far north as Delaware Bay and in waters over the outer continental shelf and inner slope, as far north as Georges Bank (CETAP, 1982; Kenney, 1990).

Genetic analyses and spatial patterns observed from aerial surveys indicate regional and seasonal distribution differences between the coastal and offshore stocks. North of Cape Hatteras, the coastal stock is thought to be restricted to waters less than 25 m (82 ft) in depth, while offshore dolphins generally range beyond the 50-m (164-ft) isobath (CETAP, 1982; Kenney, 1990; Waring et al., 2007). Mitochondrial DNA and spatial analyses from dolphins south of Cape Hatteras suggest individuals sighted within 7.5 km (4 NM) of shore are of the coastal form and those beyond 34 km (18 NM) from shore and in waters with a bottom depth greater than 34 m (112 ft) are of the offshore form (Torres et al., 2003). However, Torres et al. (2003) also found an extensive region of overlap between the coastal and offshore stocks between 7.5 (4.0 NM) and 34 km (18 NM) from shore.

In North Carolina, there is significant overlap between distributions of coastal and offshore dolphins during the summer. North of Cape Lookout, there is a separation of the two stocks by bottom depth; the coastal form occurs in nearshore waters (less than 20 m [66 ft] deep) while the offshore form is in deeper waters (greater than 40 m [131 ft] deep) (Waring et al., 2007). However, south of Cape Lookout to northern Florida, there is significant spatial overlap between the two stocks. In this region, coastal dolphins may be found in waters as deep as 31 m (102 ft) and 75 km (40 NM) from shore while offshore dolphins may occur in waters as shallow as 13 m (43 ft) (Garrison et al., 2003). Additional aerial surveys and genetic sampling are required to better understand the distribution of the two stocks throughout the year.

Discrete MUs exhibit seasonal migrations regulated by temperature and prey availability (Torres et al., 2005; Waring et al., 2007), traveling as far north as New Jersey in summer and as far south as central Florida in winter (Waring et al., 2007). During the summer, the Northern Migratory MU occurs from the New York/New Jersey border to the Virginia/North Carolina border. The Northern North Carolina MU ranges from the Virginia/North Carolina border to Cape Lookout, North Carolina during the summer months, and the Southern North Carolina MU ranges from Cape Lookout, North Carolina to Murrell's Inlet, South Carolina at this time of year. In the winter months, these three MUs overlap along the coast of North Carolina and southern Virginia. Coastal bottlenose dolphins along the western Atlantic coast may exhibit either resident or migratory patterns (Waring et al., 2007). Photo-identification studies support evidence of year-round resident bottlenose dolphin populations in Beaufort and Wilmington, North Carolina (Koster et al., 2000; Waring et al., 2007); these are the northernmost documented sites of year-round residency for bottlenose dolphins in the western North Atlantic (Koster et al., 2000). A high rate of exchange occurs between the Beaufort and Wilmington sites as well (Waring et al., 2007). Individuals from the Northern Migratory MU may enter these areas seasonally as well, as evidenced by a bottlenose dolphin tagged in 2001 in Virginia Beach who overwintered in waters between Cape Hatteras and Cape Lookout (NMFS-SEFSC, 2001a).

The offshore stock is expected to remain in the Gulf Stream during the winter months (Mead and Potter, 1990); this theory is supported by recent stable isotope analysis in teeth collected from coastal and offshore individuals, indicating significant differences in distributions between the two stocks. Despite small sample sizes, such evidence suggests offshore dolphins may not undergo seasonal migrations (Cortese, 2000).

The bottlenose dolphin is by far the most widespread and common cetacean in coastal waters of the GOMEX (Würsig et al., 2000). Bottlenose dolphins are frequently sighted near the Mississippi River Delta (Baumgartner et al., 2001) and have even been known to travel several kilometers up the Mississippi River.

Atlantic Ocean, Offshore of the Southeastern United States

In the U.S. Atlantic, the bottlenose dolphin is distributed along the coast from Long Island, New York, to the Florida Keys and up through the GOMEX. Aerial surveys conducted between 1978 and 1982 (CETAP, 1982) north of Cape Hatteras, North Carolina identified two concentrations of bottlenose dolphins, one inshore of the 25-m (82-ft) isobath and the other offshore of the 50-m (164-ft) isobath. The lowest density of bottlenose dolphins was observed over the continental shelf. It was suggested, therefore, that the coastal morphotype is restricted to waters less than 25 m (82 ft) deep north of Cape Hatteras (Kenney, 1990). Similar patterns were observed during summer months north of Cape Lookout, NC in more recent aerial surveys (Garrison and Yeung, 2001; Garrison et al., 2003). However, south of Cape Lookout during both winter and summer months, there was no clear longitudinal discontinuity in bottlenose dolphin sightings (Garrison and Yeung, 2001; Garrison et al., 2003).

Bottlenose dolphins occur in the VACAPES, CHPT and JAX/CHASN OPAREAs year-round. The bottlenose dolphin is among the most numerous marine mammal species in the coastal waters.

Atlantic Ocean, Offshore of the Northeastern United States.

Bottlenose dolphins occur year-round in waters over the continental shelf extending to deeper waters over the abyssal plain, from the Scotian Shelf south to the VACAPES OPAREA. Most of the sightings seem to occur in the vicinity of the continental slope.
In the wintertime, bottlenose dolphins may occur over the continental shelf and slope waters, from Cape Cod Bay and the tip of Georges Bank to the southern extent of the Northeast OPAREAs. During this season, the greatest number of bottlenose dolphins occurs outside the Northeast OPAREAs south towards the VACAPES OPAREA.

In the springtime, bottlenose dolphins occur primarily over the continental self and slope, in waters from Jeffreys Bank and south towards the VACAPES OPAREA. Few occurrences may be found in the deeper waters of the southern region of the Northeast OPAREAs. During the spring months, this species may occur in greater concentrations in the vicinity of the continental slope, near the tip of Georges Bank, in the center and southern regions of Narragansett Bay and Atlantic City OPAREAs respectively, and just south of the Northeast OPAREAs. Bottlenose dolphin sightings in the northeast region increase during spring, as individuals move north into the Northeast OPAREAs as water temperatures increase (NMFS-SEFSC, 2001a; Waring et al., 2004).

In the summer, the general occurrence of bottlenose dolphins extends from waters over the continental shelf to those deeper waters over the southern region of the Northeast OPAREAs. During this season, bottlenose dolphins may occur in greater concentrations in the vicinity of the continental slope, along the southern flank of Georges Bank (eastern region of Narragansett Bay OPAREA) and the southern region of the Atlantic City OPAREA, and in the waters over the New England Seamount Chain. In the fall, bottlenose dolphins may occur from Jeffreys Bank to the southern extent of the Northeast OPAREAs, in waters over the continental shelf extending to those deeper waters over the continental rise. During this season, bottlenose dolphins may be found in greater concentrations in waters over Gilbert Canyon, just east of Narragansett Bay OPAREA.

GOMEX

Bottlenose dolphins are abundant in continental shelf waters throughout the northern GOMEX (Fulling et al., 2003; Waring et al., 2006). Mullin and Fulling (2004) noted that in oceanic waters, bottlenose dolphins are encountered primarily in upper continental slope waters (less than 1,000 m [3,281 ft] in bottom depth) and that highest densities are in the northeastern Gulf.

In the winter, bottlenose dolphins may occur on the outer continental shelf and upper slope of the western Gulf and nearshore waters in the north-central and north-eastern Gulf, as well as the DeSoto Canyon region and Florida Escarpment. The large number of sightings in shelf waters off Mississippi, Alabama, and the Florida Panhandle are a result of aerial surveys conducted here during this season. It is well-known that the bottlenose dolphin occurs in nearshore waters west of the Mississippi River or over most of the Florida Shelf throughout these areas year-round; the apparent absence of occurrence in these areas is biased by the lack of survey effort during this time of year.

In the spring, bottlenose dolphins occur on the outer continental shelf and upper slope of the western Gulf and nearshore waters in the north-central and north-eastern Gulf, as well as the DeSoto Canyon region and Florida Escarpment. The large number of sightings in shelf waters off Mississippi, Alabama, and the Florida Panhandle are a result of aerial surveys conducted here during this season.

In summer, occurrence is predicted throughout the vast majority of shelf waters, as well as over the continental slope. There may be increased occurrence in shelf waters off Matagorda, Corpus Christi, and Galveston bays in Texas; on the shelf just to the west of the Mississippi Canyon; on the shelf off the Mississippi River Delta; and in an area on the Florida Shelf. Significant occurrences are anticipated near all bays in the northern Gulf.

As with the summer, occurrence in the fall is predicted throughout the vast majority of shelf waters, as well as the continental slope waters. There may be pockets of increased occurrence in shelf waters off Matagorda and Corpus Christi bays in Texas and on the Florida Shelf off Sarasota and Tampa bays; these are all well-known areas of bottlenose dolphin occurrence. Other areas of increased occurrence are over the Florida Escarpment and in an area off the Mississippi River Delta.

3.6.1.2.6 Pantropical Spotted Dolphins (*Stenella attenuata*)

Description **–** The pantropical spotted dolphin is a rather slender dolphin. This species has a dark dorsal cape, while the lower sides and belly of adults are gray. The beak is long and thin; the lips and beak tip tend to be bright white. A dark gray band encircles each eye and continues forward to the apex of the melon; there is also a dark gape-to-flipper stripe (Jefferson et al., 1993). Pantropical spotted dolphins are born spotless and develop spots as they age although the degree of spotting varies geographically (Perrin and Hohn, 1994). Some populations may be virtually unspotted (Jefferson, 2006). Adults may reach 2.6 m (8.5 ft) in length (Jefferson et al., 1993).

Status **–** The best estimate of abundance of the western North Atlantic stock of pantropical spotted dolphins is 4,439 individuals (Waring et al., 2007). There is no information on stock differentiation for pantropical spotted dolphins in the U.S. Atlantic (Waring et al., 2007). The best estimate of abundance for the pantropical spotted dolphin in the northern GOMEX is 34,067 individuals Waring et al., 2008). The pantropical spotted dolphin is the most abundant and commonly seen cetacean in deep waters of the northern GOMEX (Davis and Fargion, 1996a; Jefferson, 1996; Mullin and Hansen, 1999; Davis et al., 2000b; Würsig et al., 2000; Mullin et al., 2004).

Diving Behavior – Dives during the day generally are shorter and shallower than dives at night; rates of descent and ascent are higher at night than during the day (Baird et al., 2001). Maximum dive depths for Atlantic and pantropical spotted dolphins are 60 m and 213 m, respectively (Davis et al., 1996; Baird et al., 2001). Maximum dive times are approximately 6 minutes for Atlantic spotted dolphins and 2.6 minutes for pantropical spotted dolphins (Davis et al., 1996; Baird et al., 2001).

Acoustics and Hearing – Pantropical spotted dolphin whistles have a frequency range of 3.1 to 21.4 kHz (Thomson and Richardson, 1995). Clicks typically have two frequency peaks (bimodal) at 40 to 60 kHz and 120 to 140 kHz with estimated source levels up to 220 dB re 1 μPa peak-to-peak (Schotten et al., 2004). No direct measures of hearing ability are available for pantropical spotted dolphins, but ear anatomy has been studied and indicates that this species should be adapted to hear the lower range of ultrasonic frequencies (less than 100 kHz) (Ketten, 1992 and 1997).

Distribution **–** Pantropical spotted dolphins occur in subtropical and tropical waters worldwide (Perrin and Hohn, 1994). Although there are coastal populations in shallow nearshore waters of Central America, most pantropical spotted dolphins occur in deep oceanic waters of the upper continental slope and deeper. Pantropical spotted dolphins have been sighted along the Florida shelf and slope waters and offshore in Gulf Stream waters southeast of Cape Hatteras (Waring et al., 2007). In the Atlantic, this species is considered broadly sympatric with Atlantic spotted dolphins (Perrin and Hohn, 1994). Most sightings of this species in the GOMEX occur over the lower continental slope (Davis et al., 1998), although they are widely distributed in waters beyond the shelf edge. Pantropical and Atlantic spotted dolphins are difficult to differentiate from aerial surveys, so they are usually grouped together.

Atlantic Ocean, Offshore of the Southeastern United States

The pantropical spotted dolphin is a deep-water species (Jefferson et al., 1993). Pantropical spotted dolphins have been sighted along the Florida shelf and slope waters and offshore in Gulf Stream waters southeast of Cape Hatteras (Waring et al., 2007). In the Atlantic, this species is considered broadly sympatric with Atlantic spotted dolphins (Perrin and Hohn, 1994). The offshore form of the Atlantic spotted dolphin and the pantropical spotted dolphin can be difficult to differentiate at sea. Therefore, the low number of sightings of pantropical spotted dolphins in offshore waters may be more of a reflection of survey observers not distinguishing between the two species.

The only records documented in the VACAPES OPAREA include one sighting near the shelf break in summer, one bycatch record in winter in the southern portion of the VACAPES OPAREA, and a few sightings recorded along the continental shelf break south of Chesapeake Bay in the VACAPES OPAREA during spring. There is only one sighting in the CHPT OPAREA during winter, even though this is a time of year with increased survey effort. In JAX/CHASN, most sightings during winter are recorded in shelf waters on the North Atlantic right whale calving grounds due to increased survey effort in this area. Note that survey effort does not cover all the deep waters of the Southeast OPAREAs. Based on sighting data and known habitat preferences, occurrence is most likely in waters seaward of the shelf break throughout the Southeast OPAREAs.

Atlantic Ocean, Offshore of the Northeastern United States

Spotted dolphins are found primarily south of Georges Bank. Most spotted dolphins are sighted in the summer, while scattered occurrences are found in the spring and fall. Most of the undifferentiated spotted dolphin sightings are probably Atlantic spotted dolphins, based on habitat preference.

Spotted dolphins are not expected to occur in the Northeast OPAREAs during winter.

In the springtime, spotted dolphins primarily occur in the southwest region of the Northeast OPAREAs, in waters over the continental slope and rise, with two occurrence records indicating that they may occur further north near the southern region of the Gulf of Maine.

In the summer, spotted dolphins occur primarily in those deeper waters over the southern region of the Northeast OPAREAs, including over the New England Sea Mount Chain, with few occurrences found on the continental self, from the northern flank of Georges Bank to the southern extent of the Northeast OPAREAs. During this season, spotted dolphins may occur in greater concentrations in the waters over the northern flank of Georges Bank, outside any of the Northeast OPAREAs.

Lastly, in the fall, spotted dolphins primarily occur in deeper waters over the southern region of the Northeast OPAREAs, with the southern flank of Georges Bank representing the northern most limit of the distribution.

Pantropical spotted dolphins are widely distributed in oceanic waters of the Gulf (Mullin and Fulling, 2004). Based on sighting survey data, this is the most commonly seen cetacean in deep waters of GOMEX.

In the winter, the pantropical spotted dolphin occurs in waters beyond the shelf break. Areas of increased occurrence are over a few areas of the Florida Escarpment, including the area the Tortugas Gyre influences, and over the slope off the Texas-Louisiana border.

Spring is the season with the most survey effort and a large number of sightings throughout the entire area of survey coverage. The pantropical spotted dolphin is predicted to occur in oceanic waters throughout the vast majority of the northern Gulf. There is an area of increased occurrence in waters over the abyssal plain south of the Mississippi Canyon region. There may be areas of greater occurrence also in the DeSoto Canyon region and over the Florida Escarpment.

In summer, occurrence is predicted in oceanic waters throughout the vast majority of the northern Gulf. There may be areas of increased occurrence west of the Mississippi Canyon region and in two areas over the Florida Escarpment.

Fall is the season with of the fewest recorded sightings, likely due to decreased survey effort during this season and inclement weather conditions that can make sighting cetaceans difficult during this time of year. Patchy occurrence is predicted seaward of the shelf break in waters over the continental slope. No seasonal shifts in occurrence for this species are known for this area.

3.6.1.2.7 Atlantic Spotted Dolphin (*Stenella frontalis*)

Description **–** The Atlantic spotted dolphin tends to resemble bottlenose dolphins more than it does the pantropical spotted dolphin (Jefferson et al., 1993). In body shape, it is somewhat intermediate between the two, with a moderately long but rather thick beak. The dorsal fin is tall and falcate and there is generally a prominent spinal blaze. Adults are up to 2.3 m (7.5 ft) long and can weigh as much as 143 kg (315 lb) (Jefferson et al., 1993). Atlantic spotted dolphins are born spotless and develop spots as they age (Perrin et al., 1994b; Herzing, 1997). Some Atlantic spotted dolphin individuals become so heavily spotted that the dark cape and spinal blaze are difficult to see (Perrin et al., 1994b; Herzing, 1997).

There is marked regional variation in the adult body size of the Atlantic spotted dolphin (Perrin et al., 1987). There are two forms: a robust, heavily spotted form that inhabits the continental shelf, usually found within 250 to 350 km (135 to 189 NM) of the coast and a smaller, less-spotted form that inhabits offshore waters (Perrin et al., 1994b). The largest body size occurs in waters over the continental shelf of North America (East Coast and GOMEX) and Central America (Perrin, 2002a). The smallest Atlantic spotted dolphins are those around oceanic islands, such as the Azores and on the high seas in the western North Atlantic (Perrin, 2002a).

Status **–** The best estimate of Atlantic spotted dolphin abundance in the western North Atlantic is 50,978 individuals (Waring et al., 2007). Recent genetic evidence suggests that there are at least two populations in the western North Atlantic (Adams and Rosel, 2006), as well as possible continental shelf and offshore segregations. Atlantic populations are divided along a latitudinal boundary corresponding roughly to Cape Hatteras (Adams and Rosel, 2006).

The best estimate of abundance for the Atlantic spotted dolphin in the northern GOMEX is 37,611 individuals (Waring et al., 2008). The northern GOMEX population was confirmed to be genetically differentiated from the western North Atlantic populations (Adams and Rosel, 2006).

Diving Behavior – The only information on diving depth for this species is from a satellite-tagged individual in the GOMEX (Davis et al., 1996). This individual made short, shallow dives to less than 10 m (33 ft) and as deep as 60 m (197 ft), while in waters over the continental shelf.

Acoustics and Hearing – A variety of sounds including whistles, echolocation clicks, squawks, barks, growls, and chirps have been recorded for the Atlantic spotted dolphin (Thomson and Richardson, 1995). Whistles have dominant frequencies below 20 kHz (range: 7.1 to 14.5 kHz) but multiple harmonics extend above 100 kHz, while burst pulses consist of frequencies above 20 kHz (dominant frequency of approximately 40 kHz) (Lammers et al., 2003). Other sounds, such as squawks, barks, growls, and chirps, typically range in frequency from 0.1 to 8 kHz (Thomson and Richardson, 1995). Recently recorded echolocation clicks have two dominant frequency ranges at 40 to 50 kHz and 110 to 130 kHz, depending on source level (i.e., lower source levels typically correspond to lower frequencies and higher frequencies to higher source levels (Au and Herzing, 2003). Echolocation click source levels as high as 210 dB re 1 μPa-m peak-to-peak have been recorded (Au and Herzing, 2003). Spotted dolphins in The Bahamas were frequently recorded during agonistic/aggressive interactions with bottlenose dolphins (and their own species) to produce squawks (0.2 to 12 kHz broad band burst pulses; males and females), screams (5.8 to 9.4 kHz whistles; males only), barks (0.2 to 20 kHz burst pulses; males only), and synchronized squawks (0.1-15 kHz burst pulses; males only in a coordinated group) (Herzing, 1996).

There have been no data collected on Atlantic spotted dolphin hearing ability. However, odontocetes are generally adapted to hear high frequencies (Ketten, 1997).

Distribution **–** Atlantic spotted dolphins are distributed in warm-temperate and tropical Atlantic waters from approximately 45º N to 35º S; in the western North Atlantic, this translates to waters from northern New England to Venezuela, including the GOMEX and the Caribbean Sea (Perrin et al., 1987). Atlantic spotted dolphins may occur in both continental shelf and offshore waters (Perrin et al., 1994b). Known densities of Atlantic spotted dolphins are highest in the eastern GOMEX, east of Mobile Bay (Fulling et al., 2003). Atlantic spotted dolphins in the northern GOMEX are abundant in continental shelf waters (Fulling et al., 2003; Waring et al., 2006). In oceanic waters, this species usually occurs near the shelf break and upper continental slope waters (Davis et al., 1998; Mullin and Hansen, 1999).

Atlantic Ocean, Offshore of the Southeastern United States

The Atlantic spotted dolphin is found in tropical and warm-temperate waters of the Atlantic Ocean and the northern limit of its range is Cape Cod. The pantropical spotted dolphin is broadly sympatric (occupying the same geographical location without interbreeding) with the Atlantic spotted dolphin in the Atlantic Ocean. There are confirmed sightings of both Atlantic and pantropical spotted dolphins in the VACAPES OPAREA during winter, spring, and summer.

They generally occur in waters with a bottom depth ranging from 10 to 20 m (33 to 66 ft): however, they have an eastward extension to the 3,000-m (9,840-ft) isobath. Spotted dolphins are expected to occur in the vicinity of VACAPES OPAREA.

There are only confirmed sightings and strandings of Atlantic spotted dolphins during all seasons in and near the CHPT OPAREA.

Spotted dolphins are likely to occur from the coastline to seaward of the eastern boundary of the JAX/CHASN OPAREA throughout the year. The pantropical spotted dolphin is a deep-water species, and the Atlantic spotted dolphin may occur in both shelf and offshore waters. Sightings of spotted dolphins in coastal waters are most likely of the Atlantic spotted dolphin.

Atlantic Ocean, Offshore of the Northeastern United States

Spotted dolphins are found primarily south of Georges Basin, most of which are found in the summer, while scattered occurrences are found in the spring and fall. No occurrences of spotted dolphins are expected in the Northeast OPAREAs during the winter. Most of the undifferentiated spotted dolphin sightings are probably Atlantic spotted dolphins, based on habitat preference.

Spotted dolphins are not expected to occur in the Northeast OPAREAs during winter.

In the springtime, spotted dolphins primarily occur in the southwest region of the Northeast OPAREAs, in waters over the continental slope and rise, with two occurrence records indicating that they may occur further north near the southern region of the Gulf of Maine.

In the summer, spotted dolphins occur primarily in those deeper waters over the southern region of the Northeast OPAREAs, including over the New England Sea Mount Chain, with few occurrences found on the continental self, from the northern flank of Georges Bank to the southern extent of the Northeast OPAREAs. During this season, spotted dolphins may occur in greater concentrations in the waters over the northern flank of Georges Bank, outside any of the Northeast OPAREAs.

Lastly, in the fall, spotted dolphins primarily occur in deeper waters over the southern region of the Northeast OPAREAs, with the southern flank of Georges Bank representing the northern most limit of the distribution.

GOMEX

Atlantic spotted dolphins in the northern GOMEX are abundant in continental shelf waters (Fulling et al., 2003; Waring et al., 2006). In oceanic waters, this species usually occurs near the shelf break and upper continental slope waters (Davis et al., 1998; Mullin and Hansen, 1999). Atlantic spotted dolphins are most abundant in the eastern GOMEX (Fulling et al., 2003). On the West Florida shelf, spotted dolphins are more common in deeper waters than bottlenose dolphins (Griffin and Griffin, 2003); Griffin and Griffin (2004) reported higher densities of spotted dolphins in this area during November through May.

In winter, there may be occurrence in waters over the continental shelf and along the shelf break throughout the entire northern GOMEX (DON, 2007d). Stranding data suggest that this species may be more common than the survey data demonstrate.

Occurrence during spring is primarily in the vicinity of the shelf break from central Texas to southwestern Florida. Sighting data reflect high usage of the Florida Shelf by this species.

In summer, occurrence is primarily in waters over the continental shelf, along the shelf break throughout the entire northern GOMEX, and over the Florida Escarpment. Sighting data shows increased usage of the Florida Shelf, as well as the Florida Panhandle and inshore of DeSoto Canyon. An additional area of increased occurrence is predicted in shelf waters off western Louisiana.

In fall, the sighting data demonstrate occurrence in waters over the continental shelf and along the shelf break throughout the entire northern GOMEX. There are numerous sightings in the Mississippi River delta region and Florida Panhandle. This is the season with the least amount of systematic survey effort, and inclement weather conditions can make sighting cetaceans difficult during this time of year.

3.6.1.2.8 Spinner Dolphin (*Stenella longirostris*)

Description – The spinner dolphin has a very long, slender beak (Jefferson et al., 1993). The dorsal fin ranges from slightly falcate to triangular or even canted forward in some geographic forms. The spinner dolphin generally has a dark eye-to-flipper stripe and dark lips and beak tip (Jefferson et al., 1993). This species typically has a three-part color pattern (dark gray cape, light gray sides, and white belly). Adults can reach 2.4 m (7.9 ft) in length (Jefferson et al., 1993). There are four known subspecies of spinner dolphins and probably other undescribed ones (Perrin, 1998; Perrin et al., 1999).

Status – No estimate of abundances are currently available for the western North Atlantic stock of spinner dolphins (Waring et al., 2007). Stock structure in the western North Atlantic is unknown (Waring et al., 2007). The best estimate of abundance for spinner dolphins in the northern GOMEX is 1,989 individuals (Waring et al., 2008).

Diving Behavior – Spinner dolphins feed primarily on small mesopelagic fishes, squids, and sergestid shrimps, and they dive to at least 200 to 300 m (656 to 984 ft) (Perrin and Gilpatrick, 1994). Foraging takes place primarily at night when the mesopelagic community migrates vertically towards the surface and also horizontally towards the shore (Benoit-Bird et al., 2001; Benoit-Bird and Au, 2004). Rather than foraging offshore for the entire night, spinner dolphins track the horizontal migration of their prey (Benoit-Bird and Au, 2003). This tracking of the prey allows spinner dolphins to maximize their foraging time while foraging on the prey at its highest densities (Benoit-Bird and Au, 2003; Benoit-Bird, 2004).

Spinner dolphins are well known for their propensity to leap high into the air and spin before landing in the water; the purpose of this behavior is unknown. Norris and Dohl (1980) also described several other types of aerial behavior, including several other leap types, backslaps, headslaps, noseouts, tailslaps, and a behavior called "motorboating." Undoubtedly, spinner dolphins are one of the most aerially active of all dolphin species.

Acoustics and Hearing – Pulses, whistles, and clicks have been recorded from spinner dolphins. Pulses have a frequency range of 1 to 160 kHz, while whistles have been recorded between 1 to 25 kHz (Ketten, 1998; Lammers et al., 2003). Spinner dolphins consistently produce whistles with frequencies at the higher end of their range, at 16.9 to 17.9 kHz, with a maximum frequency for the fundamental component at 24.9 kHz (Bazúa-Durán and Au, 2002; Lammers et al., 2003). Clicks have a dominant frequency of 60 kHz (Ketten, 1998). The burst pulses are predominantly ultrasonic, often with little or no energy below 20 kHz (Lammers et al., 2003). Source levels between 195 and 222 dB re 1 μPa-m peak-to-peak have been recorded for spinner dolphin clicks (Schotten et al., 2004). There are no data available on the hearing of spinner dolphins.

Distribution **–** Spinner dolphins are found in subtropical and tropical waters worldwide, with different geographical forms in various ocean basins. The range of this species extends to near 40° latitude (Jefferson et al., 1993). Distribution in the western North Atlantic is poorly known (Waring et al., 2007). Spinner dolphins occur year-round in the deep waters of the GOMEX.

Atlantic Ocean, Offshore of the Southeastern United States

The primary distribution of spinner dolphins is offshore. In the VACAPES OPAREA, this species is thought to occur from the continental shelf break and to extend eastward of the VACAPES OPAREA boundary in association with the Gulf Stream's northern boundary. Most sighting and bycatch records are associated with the Gulf Stream in the winter and spring months (DON 2007a).

In the CHPT OPAREA, spinner dolphins are expected to occupy waters from the continental shelf edge (the 200 m [656 ft] isobath) to deep offshore waters. This species may occur in any season.

There are a few confirmed records for this species in the JAX/CHASN OPAREA and this species may occur in the waters seaward of the shelfbreak in any season.

Atlantic Ocean, Offshore of the Northeastern United States

Spinner dolphins may occur primarily in those deep waters over the southern region of the Northeast OPAREAs, with northern limits extending to 40ºN. There is one record of a spinner dolphin inside the Narragansett Bay OPAREA, which was during the summer.

GOMEX

Spinner dolphins occur year-round in the deep waters of the GOMEX. Mullin and Fulling (2004) noted that the vast majority of spinner dolphin sightings made by NMFS-SEFSC were over the continental slope in the northeastern GOMEX. During the Fritts aerial surveys of the 1980s sightings were recorded in waters off southern Florida with a bottom depth of less than 200 m (656 ft) (Fritts et al., 1983). Based on the known habitat preferences of the spinner dolphin in the GOMEX, it is now thought that these animals were misidentified (Jefferson and Schiro, 1997;

Würsig et al., 2000). It is probable that these dolphins were actually Atlantic spotted dolphins, based on known habitat preferences and distribution of this species.

In winter, spinner dolphins occur seaward of the shelf break including waters over the continental slope, primarily east of the Mississippi River, although also in the Mississippi Canyon region. The area of greatest occurrence is suggested to be southeast of DeSoto Canyon. It should be noted that this is a time of year when Beaufort sea states are highest, making detection much more difficult (Mullin et al., 2004).

During the spring, as in winter, spinner dolphins occur seaward of the shelf break including waters over the continental slope, primarily east of the Mississippi River, although also in the Mississippi Canyon region. The areas of greatest occurrence are likely to be in the DeSoto Canyon region, in waters over the Florida Escarpment, and in the area influenced by the Tortugas Gyre. It would be realistic to expect that this species is not relegated to central and eastern GOMEX and likely occurs throughout deep waters of the GOMEX, with the greatest likelihood of encountering this species being east of the Mississippi River.

In the summer, spinner dolphins may occur in the deeper waters of the north-central Gulf from the Mississippi Canyon to the Florida Panhandle. Increased occurrences of spinner dolphins may be found in the deeper waters just south of the Alabama slope.

In the fall, the presence of spinner dolphins in the GOMEX is recognized only based on sparse sighting and stranding data. The available sighting data places the species in the region of the Mississippi Canyon and DeSoto Canyon. Spring is the season that is most likely representative of what to expect for this species' occurrence, particularly since no seasonality for the species is known.

3.6.1.2.9 Clymene Dolphin (*Stenella clymene*)

Description – Due to similarity in appearance, Clymene dolphins are easily confused with spinner and short-beaked common dolphins (Fertl et al., 2003). The Clymene dolphin, however, is smaller and more robust, with a much shorter and stockier beak. The dorsal fin is tall and only slightly falcate. A three-part color pattern consisting of a dark gray cape, light gray sides, and white belly is characteristic of this species (Jefferson and Curry, 2003). The cape dips in two places, first above the eye and then below the dorsal fin. The lips and beak tip are black. There is also a dark stripe on the top of the beak, as well as a dark variably shaped "moustache" on the middle of the top of the beak. The Clymene dolphin can reach at least 2 m (7 ft) in length and weights of at least 85 kg (187 lb) (Jefferson et al., 1993).

Status **–**The population in the western North Atlantic is currently considered a separate stock for management purposes although there is not enough information to distinguish this stock from the GOMEX stock(s) (Waring et al., 2007). The numbers of Clymene dolphins off the Atlantic coast are unknown (Waring et al., 2007). The best estimate of abundance for Clymene dolphins in the northern GOMEX is 6,575 individuals (Waring et al., 2008).

Diving Behavior – There is no diving information available for this species.

Acoustics and Hearing – The only data available for this species is a description of their whistles. Clymene dolphin whistle structure is similar to that of other stenellids, but it is generally higher in frequency (range of 6.3 to 19.2 kHz) (Mullin et al., 1994a).

There are no empirical data on the hearing ability of Clymene dolphins; however, the most sensitive hearing range for odontocetes generally includes high frequencies (Ketten, 1997).

Distribution **–** Clymene dolphins are known only from the subtropical and tropical Atlantic Ocean (Perrin and Mead, 1994; Fertl et al., 2003). In the western Atlantic Ocean, Clymene dolphins are known from New Jersey to Brazil, including the GOMEX and Caribbean Sea (Fertl et al., 2003; Moreno et al., 2005). Although it is not clear if the actual density is higher, there are more Clymene dolphin records from the GOMEX than from the rest of this species' range combined (Jefferson et al., 1995; Fertl et al., 2003).

Atlantic Ocean, Offshore of the Southeastern United States

There are records of Clymene dolphins along the eastern United States as far north as New Jersey (Perrin et al., 1981). In the VACAPES OPAREA, this dolphin most likely occurs during fall, winter, and spring from the continental shelf edge to the 4,000-m (13,120-ft) isobath, with the Gulf Stream's warm water likely influencing the distribution. During the summer, this area extends farther south, to beyond the eastern boundary of the OPAREA to encompass those warm waters. Summer is the only season with sighting data for the VACAPES OPAREA.

Summer is the only season with confirmed sightings of Clymene dolphins in the CHPT OPAREA, all of which were made during NMFS surveys. Based on these sightings, and on the preference of this species for warm waters, the Clymene dolphin is most likely to occur from the 100-m (328-ft) isobath to seaward of the eastern boundary of the CHPT OPAREA during the summer.

As a tropical species, the Clymene dolphin is likely to occur in the JAX/CHASN OPAREA primarily during the summer. Clymene dolphins have been found stranded along the coast of Florida adjacent to the JAX/CHASN OPAREA and further south throughout the year.

Atlantic Ocean, Offshore of the Northeastern United States

The northernmost records of Clymene dolphins along the east coast of the U.S. are a sighting in Maryland waters (38° N) and a stranding on the coast of New Jersey (Perrin et al., 1981; Fertl et al., 2003). Based on the preference of this species for warmer waters, this species is expected to have an extralimital occurrence in the Northeast OPAREAs during all times of the year.

GOMEX

The Clymene dolphin is a deep-water species. Mullin and Hansen (1999) noted that the majority of sightings for this species in the Gulf are west of the Mississippi River. Two mass strandings of Clymene dolphins were reported in the Florida Keys: one in July 1983 and the other in December 1992 (Jefferson et al., 1995). Both mass strandings took place over the course of a few days; therefore, they appear as multiple stranding records for the two events since carcasses were collected over the course of a few days.

There are few records during the winter; this is likely more an artifact of sparse survey effort and typically poor sighting conditions (e.g., rough seas) during this time of the year, since there are no known seasonal shifts in occurrence for this species in the Gulf.

Spring is the time of the year with the most survey effort and occurrence is expected seaward of the shelf break in most of the area of the western and central Gulf, with extension into the Mississippi River Delta region and the DeSoto Canyon.
During summer, Clymene dolphins may occur in deeper waters south of the continental slope, extending from the western Louisiana to the Florida Panhandle. Fewer occurrence records are available for the summer than spring.

In the fall, there is one sighting in very deep waters and a handful of strandings that are primarily in the Florida Keys which reflect the species' occurrence in the Gulf during this time of the year. No seasonality in occurrence is known for this species; anticipated occurrence is waters seaward of the shelf break.

3.6.1.2.10 Striped Dolphin (*Stenella coeruleoalba*)

Description **–** The striped dolphin is uniquely marked with black lateral stripes from eye to flipper and eye to anus. There is also a white V-shaped "spinal blaze" originating above and behind the eye and narrowing to a point below and behind the dorsal fin (Leatherwood and Reeves, 1983). There is a dark cape and white belly. This is a relatively robust dolphin with a long, slender beak and prominent dorsal fin. This species reaches 2.6 m (8.5 ft) in length.

Status **–** The best estimate of striped dolphin abundance in the western North Atlantic is 94,462 individuals (Waring et al., 2007). The best estimate of abundance for striped dolphins in the northern GOMEX is 3,325 individuals (Waring et al., 2008).

Diving Behavior – Striped dolphins often feed in pelagic or benthopelagic zones along the continental slope or just beyond it in oceanic waters. A majority of their prey possesses luminescent organs, suggesting that striped dolphins may be feeding at great depths, possibly diving to 200 to 700 m (656 to 2,297 ft) to reach potential prey (Archer and Perrin, 1999). Striped dolphins may feed at night in order to take advantage of the deep scattering layer's diurnal vertical movements.

Acoustics and Hearing – Striped dolphin whistles range from 6 to greater than 24 kHz, with dominant frequencies ranging from 8 to 12.5 kHz (Thomson and Richardson, 1995). A single striped dolphin's hearing range, determined by using standard psycho-acoustic techniques, was from 0.5 to 160 kHz with best sensitivity at 64 kHz (Kastelein et al., 2003).

Distribution **–** Striped dolphins are distributed worldwide in cool-temperate to tropical zones. In the western North Atlantic, this species occurs from Nova Scotia southward to the Caribbean Sea, GOMEX, and Brazil (Würsig et al., 2000). Striped dolphins are usually found beyond the continental shelf, typically over the continental slope out to oceanic waters and are often associated with convergence zones and waters influenced by upwelling (Au and Perryman, 1985). Along the southeastern United States, striped dolphins are generally distributed north of

Cape Hatteras (CETAP, 1982). As noted by Mullin and Hansen (1999), this species is generally distributed in deep waters throughout the entire northern GOMEX.

Atlantic Ocean, Offshore of the Southeastern United States

Striped dolphins are usually found outside the continental shelf, typically over the continental slope out to oceanic waters and often in waters associated with convergence zones and waters influenced by upwelling. In the VACAPES OPAREA, they are likely to occur at the shelf break and over the continental slope. Sightings of striped dolphins predominantly occur seaward of the shelf break and west and north of the Gulf Stream, but not within the Gulf Stream current where it travels through the southern portion of the VACAPES OPAREA (DON, 2008m).

Aside from strandings, there is only one record of the striped dolphin near the CHPT OPAREA—a sighting that is near the northern perimeter of the OPAREA. In contrast to other Stenella species, the striped dolphin prefers more temperate waters. Striped dolphin may occur throughout the year from the 100-m (328-ft) isobath to seaward of the eastern boundary of the CHPT OPAREA. Aside from strandings, there is only one record of the striped dolphin near the CHPT OPAREA—a sighting that is near the northern perimeter of the OPAREA. The lack of sightings is likely a result of incomplete survey coverage throughout deepwaters of the CHPT OPAREA. Striped dolphin may occur throughout the year from the 100 m (328 ft) isobath seaward, past the eastern boundary of the CHPT OPAREA.

The striped dolphin may occur but are not likely in the JAX/CHASN OPAREA throughout the year from the vicinity of the continental shelf break to seaward of the eastern boundary of the JAX/CHASN OPAREA. Based on their preference, in contrast to other dolphins, for more temperate waters, striped dolphins are more likely to occur well north of the JAX/CHASN OPAREA.

Atlantic Ocean, Offshore of the Northeastern United States.

Striped dolphins may occur in the waters over the continental slope and deeper waters of the abyssal plain, from the Scotian Shelf to the southern extent of the Northeast OPAREAs.. In general, striped dolphins occur south of Georges Bank during winter, spring, and fall, with summer having the greatest number of occurrence records.

During the wintertime, striped dolphins occur primarily over the continental slope, extending south of Georges Bank towards the VACAPES OPAREA. Stranding records suggest that striped dolphins may occur as far north as the central coast of Maine.

In the springtime, striped dolphins generally occur in the waters over the continental slope and those deeper waters over the southern region of the Northeast OPAREAs, extending from the southern flank of Georges Bank and south towards the VACAPES OPAREA. Based on the relative frequency of sightings of unidentified members of the Stenella species and the known distribution of Stenella species, it is likely that many of the animals that could not be identified in the available data are actually striped dolphins.

In the summertime, the general occurrence of striped dolphins extends from waters over the continental slope to those deeper waters over the southern region of the Northeast OPAREAs, from the Scotian Shelf to off the coast of Virginia. During this season, greater occurrences of striped dolphins may be found southeast of Browns Bank, over the New England Sea Mount Chain, the eastern and southern edges of Narragansett Bay OPAREA, and south of the Atlantic City OPAREA.

In the fall, striped dolphins may occur over the continental slope and rise waters, from the southern flank of Georges Bank to the northern coast of Virginia.

GOMEX

The striped dolphin is an oceanic species likely to occur seaward of the shelf break. As noted by Mullin and Hansen (1999), this species is generally distributed in deep waters throughout the entire northern GOMEX. During the Fritts aerial surveys of the early 1980s, striped dolphins were often recorded in shallow waters around southern Florida (Fritts et al., 1983). As noted earlier, striped dolphins have an apparent preference for deep waters. It is likely these sightings in waters over the continental shelf were misidentifications of Atlantic spotted dolphins (younger animals are not spotted and have a prominent spinal blaze like striped dolphins) (Jefferson and Schiro, 1997; Würsig et al., 2000).

In winter, striped dolphins are predicted to occur in waters over the continental slope, primarily in the central and eastern Gulf. Areas of greatest concentration are predicted for the Mississippi Canyon and DeSoto Canyon regions. This is a time of year with reduced survey effort, and it is more likely that occurrence is throughout the northern GOMEX seaward of the shelf break.

During spring, occurrence for the striped dolphins is predicted throughout the northern Gulf in waters over the continental slope and abyssal plain. The greatest concentration is in the DeSoto Canyon region, with an additional area over the abyssal plain. This is the season with the most survey effort and the largest (and most widespread) number of striped dolphin sightings.

In summer, occurrence is likely throughout the northern GOMEX near the shelf break and over the continental slope.

Fall is the season with the least amount of recorded sightings, likely due to decreased survey effort during this season and inclement weather conditions that can make sighting cetaceans difficult during this time of year. It is likely that the occurrence for the striped dolphin matches that in spring, and is predicted throughout the northern Gulf in waters over the continental slope and abyssal plain

3.6.1.2.11 Short-Beaked Common Dolphin (*Delphinus delphis*)

Description – Short-beaked common dolphins are moderately robust dolphins, with a moderate-length beak, and a tall, slightly falcate dorsal fin. The beak is shorter than in long-beaked common dolphins, and the melon rises from the beak at a steeper angle (Heyning and Perrin, 1994). Short-beaked common dolphins are distinctively marked with a V-shaped saddle caused by a dip in the cape below the dorsal fin, yielding an hourglass pattern on the side of the body

(Jefferson et al., 1993). The back is dark brownish-gray, the belly is white, and the anterior flank patch is tan to cream in color. The lips are dark, and there is a dark stripe from the eye to the apex of the melon and another one from the chin to the flipper (the latter is diagnostic to the genus). There are often variable light patches on the flippers and dorsal fin. Length ranges up to about 2.3 m (7.5 ft) (females) and 2.6 m (8.5 ft) (males); however, there is substantial geographic variation (Jefferson et al., 1993).

Status – The best estimate of abundance for the Western North Atlantic *Delphinus delphis* stock is 120,743 individuals (Waring et al., 2008). There is no information available for western North Atlantic common dolphin stock structure (Waring et al., 2008).

Diving Behavior – Diel fluctuations in vocal activity of this species (more vocal activity during late evening and early morning) appear to be linked to feeding on the deep scattering layer as it rises (Goold, 2000). Foraging dives up to 200 m (656 ft) in depth have been recorded off southern California (Evans, 1994).

Acoustics and Hearing – Recorded *Delphinus delphis* vocalizations include whistles, chirps, barks, and clicks (Ketten, 1998). Clicks range from 0.2 to 150 kHz with dominant frequencies between 23 and 67 kHz and estimated source levels of 170 dB re 1 μPa. Chirps and barks typically have a frequency range from less than 0.5 to 14 kHz, and whistles range in frequency from 2 to 18 kHz (Fish and Turl, 1976; Thomson and Richardson, 1995; Ketten, 1998; Oswald et al., 2003). Maximum source levels are approximately 180 dB 1 μPa-m (Fish and Turl, 1976).

This species' hearing range extends from 10 to 150 kHz; sensitivity is greatest from 60 to 70 kHz (Popov and Klishin, 1998).

Distribution – *Delphinus* is widely distributed globally in temperate, subtropical, and tropical seas. Common dolphins occur from southern Norway to West Africa in the eastern Atlantic and from Newfoundland to Florida in the western Atlantic (Perrin, 2002b), although this species more commonly occurs in temperate, cooler waters in the northwestern Atlantic (Waring and Palka, 2002).

Atlantic Ocean, Offshore of the Southeastern United States

The common dolphin occurs year-round in the VACAPES OPAREA. Winter and spring are the seasons with the most sightings and strandings, but common dolphins may occur anytime during summer through winter from shallow shelf waters (< 50 m [164 ft]) to seaward of the 3,000 m (9,840 ft) isobath. During the summer, common dolphins are concentrated particularly in the northeastern section of the VACAPES OPAREA.

The common dolphin is uncommon off North Carolina, highly pelagic, and seldom encountered in shelf waters. It is widespread north of Cape Hatteras, but less common to the south, although it has been recorded as far south as Florida. The occurrence of common dolphins south of Cape Hatteras is questionable. Old confirmed records (pre-1970s) exist for common dolphins in this area, but no confirmed newer ones. Common dolphins are only likely to occur in the northernmost portion of the CHPT OPAREA to just south of Cape Hatteras, bounded on the east by the warmer waters of the Gulf Stream.

In the past, the common dolphin was frequently found off the northeast coast of Florida but has been conspicuously absent since about 1960. The reasons for the apparent shift of range are not known. Based on the water temperature preferences of this species, they are not likely to occur during the winter, spring, and fall, and they are not expected to occur in the JAX/CHASN OPAREA during the summer.

Atlantic Ocean, Offshore of the Northeastern United States

Common dolphins occur year round throughout the Northeast OPAREAs in continental shelf and slope waters. Along the U.S. northeastern coast, common dolphins are concentrated between the 100- and 200-m (328- and 656-ft) isobaths (Selzer and Payne, 1988; CETAP, 1982; Evans, 1994). The general distribution of common dolphins shifts to the warmer waters in southern region of the Northeast OPAREAs during winter.

In the wintertime, common dolphins occur primarily over the continental shelf and slope, in waters from off Cape Cod and Georges Bank south towards the VACAPES OPAREA. Common dolphins may also occur in the deeper waters just south of the Northeast OPAREAs. During this season, common dolphins may occur near the shelf break in the Atlantic City OPAREA, with the greatest occurrences found outside of the Northeast OPAREAs off Virginia.

In the springtime, the general occurrence of common dolphins extends from waters over the continental shelf to those deeper waters over the continental rise, from Crowell Basin to the southern extent of the Northeast OPAREAs. A few additional records (sightings) show common dolphins may also occur in the northern part of the Gulf of Maine. During this season, greater concentrations of common dolphins may occur in the vicinity of the shelf break along the southern flank of Georges Bank and in the Atlantic City OPAREA with the highest concentrations of common dolphins occurring just out of the Northeast OPAREAs in deeper water off the Virginia shelf break. Based upon their habitat preferences, it is not surprising that these animals are commonly found along the region’s major escarpments and seamounts (Evans, 1994).

In the summertime, common dolphins generally occur in continental shelf and slope waters from the Bay of Fundy and Scotian Shelf (through much of the Boston OPAREA) to northern Virginia as well as an area directly south of the Great South Channel in deeper water. The highest concentrations of common dolphins are found from the southern flank of Georges Bank into the deeper waters over the continental rise.

In the fall, common dolphins are generally found in the waters of the continental shelf seaward from the northern coast of Maine to the southern coast of Virginia, when this species is particularly abundant along the northern edge of Georges Bank. During this season, common dolphins may be found in greater concentrations in the vicinity of the continental shelf edge extending from Georges Bank to the center of the Narragansett OPAREA.

GOMEX

The common dolphin is not expected to occur within the GOMEX. All reports of Delphinus *delphis* from the GOMEX are either unreliable or were incorrect and have since been properly identified as members of the genus Stenella (Jefferson and Schiro, 1997). GOMEX

3.6.1.2.12 Fraser's Dolphin (*Lagenodelphis hosei*)

Description **–** The Fraser's dolphin reaches a maximum length of 2.7 m (8.5 ft) and is generally more robust than other small delphinids (Jefferson et al., 1993). This species has a short stubby beak, small flippers and flukes, and a small subtriangular dorsal fin. The most conspicuous feature of the Fraser's dolphin coloration is the dark band running from the face to the anus (Jefferson et al., 1997), although it is not present in younger animals and appears to be geographically variable (Jefferson, 2002a). The stripe is set off from the surrounding areas by thin, pale, cream-colored borders. There is also a dark chin-to-flipper stripe.

Status **–** No abundance estimate of Fraser's dolphins in the western North Atlantic is available (Waring et al., 2007). The best estimate of abundance for Fraser's dolphins in the northern GOMEX is unknown (Waring et al., 2007a).

Diving Behavior – There is no information available on depths to which Fraser's dolphins may dive, but they are thought to be capable of deep diving.

Acoustics and Hearing – Fraser's dolphin whistles have been recorded having a frequency range of 7.6 to 13.4 kHz in the GOMEX (duration less than 0.5 sec) (Leatherwood et al., 1993).

There are no empirical hearing data hearing data available for this species.

Distribution **–** Fraser's dolphins are found in subtropical and tropical waters around the world, typically between 30º N and 30º S (Jefferson et al., 1993). Strandings in temperate areas are considered extralimital and usually are associated with anomalously warm water temperatures (Perrin et al., 1994b). Few records are available from the Atlantic Ocean (Leatherwood et al., 1993; Watkins et al., 1994; Bolaños and Villarroel-Marin, 2003). The first record for the GOMEX was a mass stranding in the Florida Keys in 1981 (Hersh and Odell, 1986). Since then, there have been documented strandings on the west coast of Florida and in southern Texas (Clark et al., 2002).

Atlantic Ocean, Offshore of the Southeastern United States

Fraser's dolphin is considered a deep-water species. There is one record for Fraser's dolphin in the VACAPES OPAREA—a sighting made during a summer shipboard survey, a group of Fraser's dolphins and melon-headed whales was sighted in waters east of Cape Hatteras, North Carolina, with a bottom depth of 3,000 m (9,843 ft). Due to the low number of sightings and the warm-water preference of this species, Fraser's dolphins are not likely in the VACAPES OPAREA. Based on this one sighting north of the CHPT OPAREA (in the VACAPES OPAREA) in waters seaward of the 2,000-m (6,560-ft) isobath and on the warm-water preference of this species, Fraser's dolphins are also not likely to occur in the CHPT OPAREA.

There have been no confirmed sightings of Fraser's dolphin in the JAX/CHASN OPAREA. Fraser's dolphins may occur but are not likely to occur from the vicinity of the continental shelf break to waters seaward of the eastern boundary of the JAX/CHASN OPAREA throughout the year.

Atlantic Ocean, Offshore of the Northeastern United States

Fraser's dolphin is a deep-water species that prefers warm waters. The Fraser's dolphin is not expected to occur within the western North Atlantic Ocean offshore of the northeastern United States.

GOMEX

As noted by Mullin and Fulling (2004), this is a rare species that is thought to be present in the northern GOMEX. The Fraser's dolphin is an oceanic species; it is expected to occur off the shelf break. This determination was based on the distribution of sightings in the GOMEX and the known habitat preferences of this species. Fraser's dolphins are sighted over the abyssal plain in the southern GOMEX (Leatherwood et al., 1993).

3.6.1.2.13 Risso's Dolphin (*Grampus griseus*)

Description – Risso's dolphins are moderately large, robust animals reaching at least 3.8 m (12.5 ft) in length (Jefferson et al., 1993). The head is blunt and squarish without a distinct beak, and there is a vertical crease on the front of the melon. The dorsal fin is very tall and falcate. Young Risso's dolphins range from light gray to dark brownish gray and are relatively unmarked (Jefferson et al., 1993). Adults range from dark gray to nearly white and are heavily covered with white scratches and splotches.

Status – The best estimate of Risso's dolphin abundance in the western North Atlantic is 20,479 individuals (Waring et al., 2008). The best estimate of abundance for Risso's dolphins in the northern GOMEX is 1,589 individuals (Waring et al., 2008).

Diving Behavior – Individuals may remain submerged on dives for up to 30 min and dive as deep as 600 m (1,967 ft) (DiGiovanni et al., 2005).

Acoustics and Hearing – Risso's dolphin vocalizations include broadband clicks, barks, buzzes, grunts, chirps, whistles, and combined whistle and burst-pulse sounds that range in frequency from 0.4 to 22 kHz and in duration from less than a second to several seconds (Corkeron and Van Parijs, 2001). The combined whistle and burst pulse sound (2 to 22 kHz, mean duration of 8 seconds) appears to be unique to Risso's dolphin (Corkeron and Van Parijs, 2001). Risso's dolphins also produce echolocation clicks (40 to 70 microsecond [μs] duration) with a dominant frequency range of 50 to 65 kHz and estimated source levels up to 222 dB re 1 μPa-m peak-to-peak (Thomson and Richardson, 1995; Philips et al., 2003; Madsen et al., 2004a).

Baseline research on the hearing ability of this species was conducted by Nachtigall et al. (1995) in a natural setting (included natural background noise) using behavioral methods on one older individual. This individual could hear frequencies ranging from 1.6 to 100 kHz and was most sensitive between 8 and 64 kHz. Recently, the auditory brainstem response technique has been used to measure hearing in a stranded infant (Nachtigall et al., 2005). This individual could hear frequencies ranging from 4 to 150 kHz, with best sensitivity at 90 kHz. This study demonstrated that this species can hear higher frequencies than previously reported.

Distribution **–** Risso’s dolphins are distributed worldwide in cool-temperate to tropical waters from roughly 60º N to 60º S, where SSTs are generally greater than 10º C (Kruse et al., 1999). In the western North Atlantic, this species is found from Newfoundland southward to the GOMEX, throughout the Caribbean, and around the equator (Würsig et al., 2000). In general, U.S. Atlantic Risso’s dolphins occupy the mid-Atlantic continental shelf year-round, although they are rarely observed in the Gulf of Maine (Payne et al., 1984; CETAP, 1982). In the GOMEX, Risso's dolphins occur year-round in the waters from the outer continental shelf seaward over the steeper portions of the upper continental slope (Baumgartner, 1997).

Atlantic Ocean, Offshore of the Southeastern United States

During the fall and winter, the Risso’s dolphin is likely to occur from the 100-m (328-ft) isobath eastward of the boundary of the VACAPES OPAREA. In the spring and summer, Risso’s dolphins may occur from the 50-m (164-ft) isobath eastward of the boundary of the OPAREA. During all four seasons, there have been Risso’s dolphin sightings and by-catch records that are associated with the Gulf Stream.

The Risso’s dolphin is likely to occur from the 50-m (164-ft) isobath to eastward of the boundary of the CHPT OPAREA throughout the year, and year-round from the 50-m (164-ft) isobath to seaward of the eastern boundary of the JAX/CHASN OPAREA. On the basis of the sporadic sightings in shallower waters well north of the JAX/CHASN OPAREA, Risso’s dolphins are less likely to occur between the 30- and 50-m (98- and 164-ft) isobath throughout the year.

Atlantic Ocean, Offshore of the Northeastern United States

Risso’s dolphins occur year-round in waters extending from the continental shelf to the continental rise, from the Scotian Shelf to the southern extent of the Northeast OPAREAs. The overall distribution of Risso’s dolphins in the Northeast OPAREAs seems to shift south during winter. The distribution of occurrences is consistent with known occurrences and seasonal distributions (CETAP, 1982; Payne et al., 1984).

In the wintertime, Risso’s dolphins may occur over the continental shelf and slope, in waters extending from Jeffreys Bank south towards the VACAPES OPAREA.

In the springtime, the general occurrence of Risso’s dolphins may be found over the continental shelf and slope waters, extending from the southern coast of Maine.

In the summertime, Risso’s dolphins primarily occur in the vicinity of the continental slope and rise, in waters extending from Roseway Basin south towards the VACAPES OPAREA.
In the fall, Risso’s dolphins generally occur over the continental shelf and slope waters, extending from Jeffreys Bank to the southern extent of the Northeast OPAREAs. Greater

occurrences of Risso's dolphins may be found near the northeastern edge of the Atlantic City OPAREA and in the vicinity of the continental slope, off the coast of Virginia.

GOMEX

In general, Risso's dolphins occur year-round in the waters from the outer continental shelf seaward throughout the Study Area.

In the winter, Risso's dolphins are predicted to occur along the shelf break and over the continental slope. Interestingly, Mullin and Fulling (2004) found evidence for a three-fold increase in abundance in winter in the northeastern GOMEX compared to summer.

Spring is the season with the most survey effort and the largest (and most widespread) number of Rissos' dolphin sightings. Risso's dolphins are predicted not only along the shelf break and continental slope but also over deeper waters of the abyssal plain. Three areas of concentration off the DeSoto Canyon Region, off the Florida Escarpment, and in the region influenced by the Tortugas Gyre. These are all in areas of increased primary productivity, which would attract cephalopods, thereby attracting Risso's dolphins.

In the summer, Risso's dolphins may occur along the shelf break, over the continental slope, and over the abyssal plain. There may be a concentrated occurrence for Risso's dolphins in the region influenced by the Tortugas Gyre, which would be an area of increased biological productivity.

Fall is the season with the fewest recorded sightings, likely due to decreased survey effort and inclement weather conditions that can make sighting cetaceans difficult during this time of year.

3.6.1.2.14 Atlantic White-sided Dolphin (*Lagenorhynchus acutus*)

Description – The Atlantic white-sided dolphin has a stocky body with a short thick beak and tall falcate dorsal fin. Individuals have a complex color pattern (Jefferson et al., 1993). They are black on the back, top of the beak, flippers, and flukes; the sides are gray. There is a white band below the dorsal that connects with a yellow band on the tail stock. Adults are 2.5 to 2.8 m (8.2 to 9.2 ft) in length.

Status – Three stock units have been suggested for the Atlantic white-sided dolphin in the western North Atlantic: Gulf of Maine, Gulf of St. Lawrence, and Labrador Sea (Waring et al., 2008). The best estimate of abundance for the western North Atlantic stock of white-sided dolphins is 63,368 individuals (Waring et al., 2008).

Diving Behavior – There is no diving information available for this species. However, it is known that Atlantic white-sided dolphins feed on pelagic and benthopelagic fishes, such as capelin, herring, hake, sand lance, smelt, and cod and cephalopods, such as squids (Katona et al., 1978; Sergeant et al., 1980; Kenney et al., 1985; Selzer and Payne, 1988; Waring et al., 1990; Weinrich et al., 2001).

Acoustics and Hearing – The only information available on Atlantic white-sided vocalizations is that the dominant frequency is 6 to 15 kHz (Thomson and Richardson, 1995). There is no hearing data available for this species.

Distribution **–** Atlantic white-sided dolphins are found in cold temperate to subpolar waters of the North Atlantic, from New England in the west and France in the east, north to southern Greenland, Iceland, and southern Norway (Jefferson et al., 1993). This species is most common over the continental shelf from Hudson Canyon north to the Gulf of Maine (Palka et al., 1997). Virginia and North Carolina appear to represent the southern edge of the range (Testaverde and Mead, 1980). Sighting data indicate seasonal shifts in distribution, perhaps a reflection of an inshore/offshore movement (CETAP, 1982; Payne et al., 1990b; Northridge et al., 1997). The spatial distribution of Atlantic white-sided dolphin sightings closely parallels sand lance distribution and abundance patterns (Selzer and Payne, 1988; Kenney et al., 1996).

During January to April, low numbers of white-sided dolphins may be found from Georges Bank to Jeffreys Ledge. Even lower numbers are found south of Georges Bank (also when a few strandings have been collected on Virginia and North Carolina beaches) (Payne et al., 1990b; Palka et al., 1997; Waring et al., 2004). From June through September, large numbers of white-sided dolphins are found from Georges Bank to the lower Bay of Fundy (Payne et al., 1990b; Waring et al., 2004). During this time, strandings occur from New Brunswick, Canada to New York (Palka et al., 1997). From October to December, white-sided dolphins occur at intermediate densities from southern Georges Bank to the southern Gulf of Maine. Sightings occur year-round south of Georges Bank, particularly around Hudson Canyon, but in low densities (CETAP, 1982; Payne et al., 1990b; Palka et al., 1997; Waring et al., 2004).

Atlantic white-sided dolphins have the ability to move through a wide-ranging area; a rehabilitated individual was tracked over 300 km (162 NM) in 64.3 hrs (Mate et al., 1994). Photo-identification work also indicates widespread movements (Weinrich et al., 2001).

Atlantic Ocean, Offshore of the Southeastern United States

This dolphin is known to occur only in the northern portion of the VACAPES OPAREA in all seasons, based on its preference for colder waters. Sightings are recorded mostly in the northern VACAPES OPAREA and vicinity. Strandings and bycatch records are also documented near the VACAPES OPAREA. Due to this species' preference for colder waters, the Gulf Stream may be a southern boundary for Atlantic white-sided dolphin distribution. This species is likely to occur primarily in waters over the continental shelf throughout the VACAPES OPAREA year-round. However, distribution may also range further offshore which is evidenced by the sighting records offshore in waters over the continental slope in and near the VACAPES OPAREA. Atlantic white-sided dolphins are not expected to occur in the CHPT or JAX/CHASN OPAREAs.

Atlantic Ocean, Offshore of the Northeastern United States

Atlantic white-sided dolphins occur year-round throughout most of the northern region of the Northeast OPAREAs in continental shelf and slope waters. Overall, spring, summer, and fall have higher occurrences of Atlantic white-sided dolphins than winter.

In the wintertime, Atlantic white-sided dolphins occur primarily in the continental shelf and slope waters, in the western and southern regions of the Gulf of Maine, with scattered occurrences extending to the southern region of the Northeast OPAREAs. These areas include Jeffreys Ledge and a small section of Georges Bank, both of which have been documented as areas of low dolphin abundance during winter months (Payne et al., 1990b; Palka et al., 1997; Waring et al., 2004).

In the springtime, Atlantic white-sided dolphins occur primarily over the continental shelf and slope, in waters extending from Jeffreys Bank and Roseway Basin to the southern region of the Northeast OPAREAs. Atlantic white-sided dolphins may occur in greater concentrations in waters over the northern flank of Georges Bank, east of Cape Cod, and over Nantucket Shoals in the northern region of the Narragansett Bay OPAREA. During spring, the occurrence of Atlantic white-sided dolphins in the Northeast OPAREAs coincides with the distribution and period of peak abundance of sand lance.

In the summer, the general occurrence of Atlantic white-sided dolphins extends from waters over the continental shelf to those deeper waters over the continental rise, from the Bay of Fundy and the Scotian Shelf to the southern region of the Northeast OPAREAs. During this season, greater concentrations of Atlantic white-sided dolphins may be found in the waters over Jordan Basin, east of Cape Cod, and east of the Northeast Channel.

In the fall, Atlantic white-sided dolphins are generally found in waters over the continental shelf and slope, from the Bay of Fundy and the Scotian Shelf to just east of New Jersey. During this season, Atlantic white-sided dolphins may occur in greater concentrations in waters over Jeffreys Bank and just east of Cape Cod. The distribution of white-sided dolphins is more dispersed throughout the Gulf of Maine in fall than in spring due to the reduced availability of sand lance in the area (Selzer and Payne, 1988).

GOMEX

The white-sided dolphin is not expected to occur within the GOMEX.

3.6.1.2.15 White-beaked Dolphin (*Lagenorhynchus albirostris*)

Description – The white-beaked dolphin is an extremely robust dolphin, which reaches lengths of 3.2 m and a maximum weight of 354 kg (780 lb) (Jefferson et al., 1993; Reeves et al., 1999b). The beak is short and thick. The back and sides of this species are basically black or dark gray. The beak and most of the belly are white to light gray, and the beak is often mottled (Jefferson et al., 1993). There may be dark or light flecks in the area between the eye and the flipper.

Status –At least two white-beaked dolphin stocks are present in the North Atlantic: one in the eastern and one in the western (Waring et al., 2007). The total number of white-beaked dolphins in U.S. waters is unknown. The best and only recent abundance estimate for the western North Atlantic white-beaked dolphin is 2,003, an estimate derived aerial survey data collected in August 2006. However, it is assumed this estimate is negatively biased because the survey only covered part of the species' habitat (Waring et al., 2007).

Diving Behavior – There is no information available on depths to which the white-beaked dolphin may dive.

Acoustics and Hearing – White-beaked dolphins produce sounds such as clicks, squeals, and whistles. The clicks are presumably used for echolocation (Rasmussen et al., 2002). Maximum source levels of clicks are 219 dB re 1 µPa-m peak-to-peak with a peak frequency of 120 kHz (Rasmussen et al., 2002). Squeals range from 6.5 to 15 kHz (noted in Lien et al., 2001). Rasmussen et al. (2006) claim that whistles are used as an indicator of activity state, where a high occurrence of whistles indicates an increased level of activity. These whistles have been reported to have fundamental frequencies up to 35 kHz with source levels ranging between 118 and 167 dB re 1 µPa (rms) (Rasmussen et al., 2006).

Nachtigall et al. (2008) conducted the first underwater audiograms (non-invasive AEPs) of two wild white-beaked dolphins (one male, one female) near Iceland in a temporary capture-release study. The female showed two threshold frequencies (50 and 64 kHz) while the male's audiogram presented the typical U shape for previously measured toothed cetaceans with a range from 16 to 181 kHz. Nachtigall et al. (2008) suggested that the white-beaked dolphin audiogram was as sensitive as that for the harbor porpoise and with the highest frequency hearing for delphinids measured.

Distribution **–** The white-beaked dolphin is found only in cold-temperate and subarctic North Atlantic waters and appears to be more common in eastern rather than western waters (Lien et al., 2001). The range of the white-beaked dolphin overlaps that of the Atlantic white-sided dolphin, but the white-beaked dolphin is regarded as the more northerly of the two species (Leatherwood and Reeves, 1983). In addition, studies in the eastern North Atlantic suggest that the white-beaked dolphin has a more coastal feeding habit in contrast to the Atlantic white-sided dolphin which mainly feeds offshore (Das et al., 2003).

In the western North Atlantic, white-beaked dolphins occur from eastern Greenland through the Davis Strait and south to Massachusetts (Lien et al., 2001). White-beaked dolphins are found near the northern limits of their range between spring and late fall; they appear to winter further south and some may remain there until late spring or early summer (Leatherwood and Reeves, 1983). The northward shift that occurs during the summer appears to follow the progression of spawning capelin (Lien et al., 2001).

Off the northeastern United States, white-beaked dolphin sightings are concentrated in the western Gulf of Maine and around Cape Cod (CETAP, 1982). Prior to the 1970s, these dolphins were found primarily over the continental shelf in the Gulf of Maine and over Georges Bank. However, since then, they have occurred primarily in waters over the continental slope and have been replaced by Atlantic white-sided dolphins (Sergeant et al., 1980; Katona et al., 1993). This shift may result from a sand lance increase and herring decline in continental shelf waters (Payne et al., 1986; Payne et al., 1990b; Kenney et al., 1996).

Atlantic Ocean, Offshore of the Southeastern United States

The white-beaked dolphin is found in the North Atlantic Ocean in cold-temperate and subarctic waters. The lone sighting record for the white-beaked dolphin in the VACAPES OPAREA occurred on the continental shelf edge during spring. Any occurrences of the white-beaked dolphin in the VACAPES OPAREA are considered to be extralimital. It is unlikely that this species would occur in the VACAPES OPAREA during any season. The species is not expected to occur in the CHPT and JAX/CHASN OPAREAs.

Atlantic Ocean, Offshore of the Northeastern United States

In general, white-beaked dolphins occur primarily in waters over the continental shelf from the Bay of Fundy to the Hudson Canyon. Overall, winter, spring, and summer have more occurrences of white-beaked dolphins in the Northeast OPAREAs than the fall.

In the wintertime, white-beaked dolphins occur primarily in continental shelf waters, from just west of Georges Basin to Hudson Canyon. During this season, the greatest concentration of white-beaked dolphins may occur just west of Georges Basin. In the springtime, white-beaked dolphins occur in continental shelf waters, in the western and southern region of the Gulf of Maine, and Nantucket Shoals. During this season, a greater concentration of white-beaked dolphins may occur over Nantucket Shoals, in the northern region of Narragansett Bay OPAREA. In the summertime, the general occurrence of white-beaked dolphins extends from the Bay of Fundy and Browns Bank to northern New Jersey, with a few occurrence records found in the northern region of Narragansett Bay OPAREA, primarily in waters over the continental shelf. A northward shift in white-beaked dolphin occurrence was noted, making it likely that this species may occur further north of the Northeast OPAREAs during this time of year (Lien et al., 2001). In the fall, white-beaked dolphins may be found in Cape Cod Bay and in waters over the eastern tip of Georges Bank.

GOMEX

The white-beaked dolphin is not expected to occur within the GOMEX.

3.6.1.2.16 Melon-headed Whale (*Peponocephala electra*)

Description **–** Melon-headed whales at sea closely resemble pygmy killer whales; both species have a blunt head with little or no beak. Melon-headed whales have pointed (versus rounded) flippers and a more triangular head shape than pygmy killer whales (Jefferson et al., 1993). The body is charcoal gray to black, with unpigmented lips (which often appear light gray, pink, or white) and a white urogenital patch (Perryman et al., 1994). This species also has a triangular face “mask” and indistinct cape (which dips much lower below the dorsal fin than that of pygmy killer whales). Melon-headed whales reach a maximum length of 2.75 m (9.02 ft) (Jefferson et al., 1993).

Status **–** There are no abundance estimates for melon-headed whales in the western North Atlantic (Waring et al., 2007). The best estimate of abundance for melon-headed whales in the northern GOMEX is 2,283 individuals (Waring et al., 2008).

Diving Behavior – Melon-headed whales prey on squids, pelagic fishes, and occasionally crustaceans. Most fish and squid prey are mesopelagic in waters up to 1,500 m deep, suggesting that feeding takes place deep in the water column (Jefferson and Barros, 1997). There is no information on specific diving depths for melon-headed whales.

Acoustics and Hearing – The only published acoustic information for melon-headed whales is from the southeastern Caribbean (Watkins et al., 1997). Sounds recorded included whistles and click sequences. Recorded whistles have dominant frequencies between 8 and 12 kHz; higher-level whistles were estimated at no more than 155 dB re 1 μPa-m (Watkins et al., 1997). Clicks had dominant frequencies of 20 to 40 kHz; higher-level click bursts were estimated to be about 165 dB re 1 μPa-m (Watkins et al., 1997). No empirical data on hearing ability for this species are available.

Distribution **–** Melon-headed whales occur worldwide in subtropical and tropical waters. There are very few records for melon-headed whales in the North Atlantic (Ross and Leatherwood, 1994; Jefferson and Barros, 1997). Maryland is thought to represent the extreme of the northern distribution for this species in the northwest Atlantic (Perryman et al., 1994; Jefferson and Barros, 1997). The first two occurrence records for this species in the GOMEX were strandings in Texas and Louisiana during 1990 and 1991, respectively (Barron and Jefferson, 1993).

Atlantic Ocean, Offshore of the Southeastern United States

Melon-headed and pygmy killer whales can be difficult to distinguish from one another, and on many occasions only a determination of “pygmy killer whale/melon-headed whale” can be made. Two sightings of melon-headed whales are recorded in deep (greater than 2,500 m [8,202 ft]) offshore waters along the path of the Gulf Stream in the southern VACAPES OPAREA. Based on warm water preferences, melon-headed whale occurrence in the VACAPES OPAREA during winter is likely influenced by the Gulf Stream. The only sighting of melon-headed whales in the vicinity of the CHPT OPAREA is the more southerly of the two recorded in the offshore waters of the VACAPES OPAREA (DON, 2008m). One stranding of a melon-headed whale is recorded just inshore of the JAX/CHASN OPAREA along the coast of Florida. In March 2006, five adult melon-headed whales mass stranded along the central Atlantic coast of Florida just south of the OPAREA (Bossart et al., 2007). This is the first reported mass stranding of this species in the southeastern United States. The melon-headed whale is an oceanic species; it is likely to occur seaward of the shelf break year-round throughout the Southeast OPAREAs.

Atlantic Ocean, Offshore of the Northeastern United States

The melon-headed whale is not expected to occur within the western North Atlantic Ocean offshore of the northeastern United States.

GOMEX

The melon-headed whale is an oceanic species; this is confirmed by the distribution of sighting records, which show the species to occur in waters seaward of the shelf break. Mullin and Hansen (1999) noted that melon-headed whales appear to be more frequently sighted west of the Mississippi River. This is supported by the distribution of sighting records in the GOMEX. No seasonality to their occurrence is expected. The large number of sightings during the spring is due to high survey coverage during this time of year.

3.6.1.2.17 Pygmy Killer Whale (*Feresa attenuata*)

Description **–** The pygmy killer whale is often confused with the melon-headed whale and less often with the false killer whale. Flipper shape is the best distinguishing characteristic; pygmy killer whales have rounded flipper tips (Jefferson et al., 1993). The body of the pygmy killer whale is somewhat slender (especially posterior to the dorsal fin) with a rounded head that has little or no beak (Jefferson et al., 1993). The color of this species is dark gray to black with a prominent narrow cape that dips only slightly below the dorsal fin and a white to light gray ventral band that widens around the genitals. The lips and snout tip are sometimes white. Pygmy killer whales reach lengths of up to 2.6 m (8.5 ft) (Jefferson et al., 1993).

Status **–** There are no estimates of abundances for pygmy killer whales in the western North Atlantic (Waring et al., 2007). The best estimate of abundance for pygmy killer whales in the northern GOMEX is 323 individuals (Waring et al., 2008).

Diving Behavior – There is no diving information available for this species.

Acoustics and Hearing – The pygmy killer whale emits short duration, broadband signals similar to a large number of other delphinid species (Madsen et al., 2004b). Clicks produced by pygmy killer whales have centroid frequencies (the frequency which divides the energy in the click into two equal portions) between 70 and 85 kHz; there are bimodal peak frequencies between 45 and 117 kHz. The estimated source levels are between 197 and 223 dB re 1 μPa-m peak-to-peak (Madsen et al., 2004b). These clicks possess characteristics of echolocation clicks (Madsen et al., 2004b).

There are no empirical hearing data available for this species.

Distribution **–** Pygmy killer whales have a worldwide distribution in tropical and subtropical waters, generally not ranging north of 40º N or south of 35º S (Jefferson et al., 1993). Most records from outside the tropics are associated with unseasonable intrusions of warm water into higher latitudes (Ross and Leatherwood, 1994). There are relatively few records of this species in the western North Atlantic; this species does not appear to be common in the GOMEX (Davis and Fargion, 1996a; Jefferson and Schiro, 1997; Davis et al., 2000b; Würsig et al., 2000). Würsig et al. (2000) suggested that the sparse number of sightings might be at least in part due to the somewhat cryptic behavior of the pygmy killer whale.

Atlantic Ocean, Offshore of the Southeastern United States

Only one confirmed record, a fall stranding north of Cape Hatteras, is documented for pygmy killer whales in the VACAPES OPAREA and vicinity. Based on warm water preferences, pygmy killer whale occurrence in the VACAPES OPAREA during winter is likely influenced by the Gulf Stream. Few strandings and an offshore sighting are recorded near the CHPT OPAREA. Records of pygmy killer whales in this region include several strandings inshore of the JAX/CHASN OPAREA and two sightings in offshore waters of the JAX/CHASN OPAREA. The pygmy killer whale is an oceanic species; occurrence is likely seaward of the shelf break year-round throughout the Southeast OPAREAs.

Atlantic Ocean, Offshore of the Northeastern United States

The pygmy killer whale should be considered rare off the northeastern United States during all times of the year; as it primarily occurs in tropical waters. Although no sightings have occurred within the Northeast OPAREAs, there are four occurrence records for this species off the northeastern United States: one sighting during August 1981 (CETAP, 1982) and three during the course of two days of a NMFS shipboard survey in July 1995. The closest sighting was made during July 1995, 31.5 km (69.4 NM) south of the southwestern corner of the Narragansett OPAREA.

GOMEX

As stated previously, pygmy killer whales and melon-headed whales can be difficult to distinguish from one another, and on many occasions, only a determination of "pygmy killer whale/melon-headed whale" can be made. The occurrence of both species is considered similar and therefore were combined. In the northern GOMEX, the pygmy killer whale is found primarily in deeper waters beyond the continental shelf (Davis and Fargion, 1996a; Davis et al., 2000b; Würsig et al., 2000) extending out to waters over the abyssal plain. Pygmy killer whales are thought to occur year-round in the Gulf in small numbers (Würsig et al., 2000). No seasonality to their occurrence is expected. The large number of sightings during the spring is due to high survey coverage during this time of year.

3.6.1.2.18 False Killer Whale (*Pseudorca crassidens*)

Description **–** The false killer whale is a large, dark gray to black dolphin with a faint gray patch on the chest and sometimes light gray areas on the head (Jefferson et al., 1993). The false killer whale has a long slender body, a rounded overhanging forehead, and little or no beak (Jefferson et al., 1993). The dorsal fin is falcate and slender. The flippers have a characteristic hump on the S-shaped leading edge—this is perhaps the best characteristic for distinguishing this species from the other "blackfish" (an informal grouping that is often taken to include pygmy killer, melon-headed, and pilot whales; Jefferson et al., 1993). Individuals reach maximum lengths of 6 m (20 ft) (Jefferson et al., 1993).

Status **–** There are no abundance estimates available for this species in the western North Atlantic (Waring et al., 2007). The best estimate of abundance for false killer whales in the northern GOMEX is 777 individuals (Waring et al., 2008).

Diving Behavior – Few diving data are available, although individuals are documented to dive as deep as 500 m (1,640 ft) (Odell and McClune, 1999). Shallower dive depths (maximum of 53 m [174 ft]; averaging from 8 to 12 m [26 to 39 ft]) have been recorded for false killer whales in Hawaiian waters.

Acoustics and Hearing – Dominant frequencies of false killer whale whistles are from 4 to 9.5 kHz, and those of their echolocation clicks are from either 20 to 60 kHz or 100 to 130 kHz depending on ambient noise and target distance (Thomson and Richardson, 1995). Click source levels typically range from 200 to 228 dB re 1 µPa-m (Ketten, 1998). Recently, false killer whales recorded in the Indian Ocean produced echolocation clicks with dominant frequencies of about 40 kHz and estimated source levels of 201-225 dB re 1 µPa-m peak-to-peak (Madsen et al., 2004b).

False killer whales can hear frequencies ranging from approximately 2 to 115 kHz. Their best hearing sensitivity ranges from 16 to 64 kHz (Thomas et al., 1988). Additional behavioral audiograms of false killer whales support a range of best hearing sensitivity between 16 and 24 kHz, with peak sensitivity at 20 kHz (Yuen et al., 2005). The same study also measured audiograms using the ABR technique, which came to similar results, with a range of best hearing sensitivity between 16 and 22.5 kHz, peaking at 22.5 kHz (Yuen et al., 2005). Behavioral audiograms in this study consistently resulted in lower thresholds than those obtained by ABR.

Distribution **–** False killer whales are found in tropical and temperate waters, generally between 50°S and 50°N latitude with a few records north of 50°N in the Pacific and the Atlantic (Baird et al., 1989; Odell and McClune, 1999). False killer whales are primarily offshore animals, although they do come close to shore, particularly around oceanic islands (Baird, 2002). Most sightings in the GOMEX have been made in oceanic waters greater than 200 m (656 ft) deep, although there are some sightings in waters over the continental shelf (Davis and Fargion, 1996a). Inshore movements are occasionally associated with movements of prey and shoreward flooding of warm ocean currents (Stacey et al., 1994).

Atlantic Ocean, Offshore of the Southeastern United States

The false killer whale is found primarily in deep-water and offshore areas in tropical and warm-temperate waters. The warm waters of the Gulf Stream likely influence occurrence in the southern VACAPES OPAREA. A small number of sightings and strandings are recorded near the VACAPES OPAREA; the sightings reflect the preference of this species for offshore waters. A small number of sightings are recorded in the CHPT OPAREA. A small number of sightings are recorded in offshore waters of the JAX/CHASN OPAREA. Strandings are also recorded in this region. Occurrence is likely seaward of the shelf break throughout the Southeast OPAREAs year-round.

Atlantic Ocean, Offshore of the Northeastern United States

The false killer whale is distributed worldwide throughout warm temperate and tropical oceans. False killer whales may occur in waters over Jeffreys Bank, south of the southern flank of Georges Bank and Narragansett Bay OPAREA, and in the vicinity of Cape Cod during summer, fall, and winter. No sightings have occurred during the spring.

GOMEX

Most sightings in the GOMEX have been made seaward of the shelf break, although there are also sightings from over the continental shelf (Davis and Fargion, 1996a; Jefferson and Schiro, 1997; Mullin and Fulling, 2004). Mullin and Hansen (1999) and Mullin and Fulling (2004) reported that most NMFS-SEFSC sightings were east of the Mississippi River. There is the possibility of encountering false killer whales between the 50-m (164-ft) isobath and the shelf break based on the fact that false killer whales sometimes make their way into shallower waters, as well as the many sightings reported by sport fishermen in the mid-1960s of "blackfish" (most likely false killer whales based on the descriptions) in waters offshore of Pensacola and Panama City, Florida (Brown et al., 1966). There were also occasional reports of fish stealing by these animals (the false killer whale frequently has been implicated in such fishery interactions). No seasonal differences in the occurrence patterns of this species are expected in the GOMEX.

3.6.1.2.19 Killer Whale (*Orcinus orca*)

Description **–** Killer whales are probably the most instantly recognizable of all the cetaceans. The black-and-white color pattern of the killer whale is striking, as is the tall, erect dorsal fin of the adult male (1 to 2 m [3 to 6 ft] in height). The white oval eye patch and variably shaped saddle patch, in conjunction with the shape and notches in the dorsal fin, help in identifying individuals. The killer whale has a blunt head with a stubby, poorly defined beak and large, oval flippers. Females may reach 8 (25 ft) m in length and males 9 m (30 ft) (Dahlheim and Heyning, 1999). This is the largest member of the dolphin family.

Status **–** There are no estimates of abundance for killer whales in the western North Atlantic (Waring et al., 2007). Most cetacean taxonomists agree that multiple killer whale species or subspecies occur worldwide (Krahn et al., 2004; Waples and Clapham, 2004). However, at this time, further information is not available, particularly for the western North Atlantic. The best estimate of abundance for killer whales in the northern GOMEX is 49 individuals (Waring et al., 2008). The GOMEX population is considered a separate stock for management purposes, although there is currently no information to differentiate this stock from the Atlantic Ocean stock(s) (Waring et al., 2008).

Diving Behavior – The maximum recorded depth for a free-ranging killer whale dive was 264 m (866 ft) off British Columbia (Baird et al., 2005a). A trained killer whale dove to 260 m (853 ft) (Dahlheim and Heyning, 1999). The longest duration of a recorded dive was 17 min (Dahlheim and Heyning, 1999). However, shallower dives were much more common for eight tagged individuals, where less than three percent of all dives examined were greater than 30 m (98 ft) in depth (Baird et al., 2003a).

Acoustics and Hearing – Killer whales produce a wide variety of clicks and whistles, but most of this species' social sounds are pulsed, with frequencies ranging from 0.5 to 25 kHz (dominant frequency range: 1 to 6 kHz) (Thomson and Richardson, 1995). Echolocation clicks recorded for Canadian killer whales foraging on salmon have source levels ranging from 195 to 224 dB re: 1 μPa-m peak-to-peak, a center frequency ranging from 45 to 80 kHz, and durations of 80 to 120 μs (Au et al., 2004). Echolocation clicks from Norwegian killer whales feeding on herring were at a considerably lower source level, frequency, and duration than the previously mentioned study ranging from 173 to 202 re 1 μPa-m peak-to-peak, . 22 to 49 kHz, and 31 to 203 μs, respectively (Simon et al., 2007). Source levels associated with social sounds have been calculated to range from 131 to 168 dB re 1 μPa-m and have been demonstrated to vary with vocalization type (e.g., whistles: average source level of 140.2 dB re 1 μPa-m, variable calls: average source level of 146.6 dB re 1 μPa-m, and stereotyped calls: average source level 152.6 dB re 1 μPa-m) (Veirs, 2004). Additionally, killer whales modify their vocalizations depending on social context or ecological function (i.e., short-range vocalizations [less than 10 km [5 NM] range] are typically associated with social and resting behaviors and long-range vocalizations [10 to 16 km [5 to 9 NM) range] are associated with travel and foraging) (Miller, 2006). Likewise, echolocation clicks are adapted to the type of fish prey (Simon et al., 2007).

Acoustic studies of resident killer whales in British Columbia have found that they possess dialects, which are highly stereotyped, repetitive discrete calls that are group-specific and are shared by all group members (Ford, 2002). These dialects likely are used to maintain group identity and cohesion and may serve as indicators of relatedness that help in the avoidance of inbreeding between closely related whales (Ford, 1991, 2002). Dialects have been documented in northern Norway (Ford, 2002) and southern Alaskan killer whale populations (Yurk et al., 2002) and are likely occur in other regions as well.

Both behavioral and ABR techniques indicate killer whales can hear a frequency range of 1 to 100 kHz and are most sensitive at 20 kHz, which is one of the lowest maximum-sensitivity frequencies known among toothed whales (Szymanski et al., 1999).

Distribution **–** Killer whales are found throughout all oceans and contiguous seas, from equatorial regions to polar pack ice zones of both hemispheres. Although found in tropical waters and the open ocean, killer whales are most numerous in coastal waters and at higher latitudes (Dahlheim and Heyning, 1999). Ford (2002) noted that this species has a sporadic occurrence in most regions. In the western North Atlantic, killer whales are known from the polar pack ice southward to Florida, the Lesser Antilles, and the GOMEX (Rice, 1998), where they have been sighted year-round (Jefferson and Schiro, 1997; O'Sullivan and Mullin, 1997; Würsig et al., 2000). It is not known whether killer whales in the GOMEX range more widely into the Caribbean Sea and the adjacent North Atlantic (Würsig et al., 2000). Year-round killer whale occurrence in the western North Atlantic is considered to be south of 35° N (Katona et al., 1988).

Atlantic Ocean, Offshore of the Southeastern United States

Several killer whale sightings are recorded in both shallow and deep waters of the VACAPES OPAREA and vicinity. A small number of killer whale sightings are recorded in both shallow and deepwaters of the CHPT and JAX/CHASN OPAREAs and vicinity. Strandings are also reported along the coasts of North Carolina and Florida. Occurrence would be year-round, and at all depths throughout the Southeast, based on sighting data and the diverse habitat preferences of this species.

Atlantic Ocean, Offshore of the Northeastern United States

Killer whales may occur year-round in the Northeast OPAREAs, primarily in waters over the continental shelf and rise, from the Bay of Fundy to New Jersey. They are characterized as uncommon in waters of the U.S. Atlantic EEZ.

GOMEX

Killer whales in the GOMEX are sighted most often in waters with bottom depths greater than 200 m (656 ft) (averaging 1,242 m [4,075 ft]; range of 256 to 2,652 m [840 to 8,701 ft]), although there have also been occasional sightings over the continental shelf (Jefferson and

Schiro, 1997; O'Sullivan and Mullin, 1997). Killer whale sightings in the northern GOMEX are generally clumped in a broad region south of the Mississippi River Delta (O'Sullivan and Mullin, 1997). It should be noted, however, that southern Texas (specifically, the Port Aransas area) seems to be an area where there are a number of anecdotal reports of killer whale sightings.

Killer whales are not expected to occur during the winter, however, there are two historical stranding records in the Florida Keys (O'Sullivan and Mullin, 1997). There was a sighting of 14 individuals reported 90 NM (167 km) off Port Aransas, Texas on January 18, 2004 (Mauch, 2004; McCune, 2004).

During the spring, O'Sullivan and Mullin's (1997) assessment showed that killer whales are generally clumped south of the Mississippi River Delta. There is an area of concentration in deep waters of the Gulf that is likely a reflection of a sighting(s) of a large group(s) of individuals and probably does not reflect a true area of concentration for the species.

During summer, there are certainly fewer sightings, with the Mississippi River Delta region and southern Texas having the most sightings.

During the fall, killer whales are not expected to occur, however, this is the season with the least amount of survey effort, and inclement weather conditions can make sighting cetaceans difficult during this time of year. Additionally, as noted earlier, killer whales are only sporadically sighted in the Gulf.

3.6.1.2.20 Long-finned and Short-finned Pilot Whales (*Globicephala* spp.)

Description **–** Pilot whales are among the largest dolphins, with long-finned pilot whales potentially reaching 5.7 m (19 ft) (females) and 6.7 m (22 ft) (males) in length. Short-finned pilot whales may reach 5.5 m (18 ft) (females) and 6.1 m (20 ft) (males) in length (Jefferson et al., 1993). The flippers of long-finned pilot whales are extremely long, sickle shaped, and slender, with pointed tips, and an angled leading edge that forms an "elbow." Long-finned pilot whale flippers range from 18 to 27 percent of the total body length. Short-finned pilot whales have flippers that are somewhat shorter than long-finned pilot whale at 16 to 22 percent of the total body length (Jefferson et al., 1993).

Status **–** The best estimate of pilot whale abundance (combined short-finned and long-finned) in the western North Atlantic is 31,139 individuals (Waring et al., 2008). Fullard et al. (2000) proposed a stock structure for long-finned pilot whales in the North Atlantic that was correlated with sea-surface temperature. This involved a cold-water population west of the Labrador and North Atlantic current and a warm-water population that extended across the North Atlantic in the warmer water of the Gulf Stream. The best estimate of abundance for the short-finned pilot whale in the northern GOMEX is 716 individuals (Waring et al., 2008).

Diving Behavior – Pilot whales are deep divers, staying submerged for up to 27 min and routinely diving to 600 to 800 m (1,967 to 2,625 ft) (Baird et al., 2003a; Aguilar de Soto et al., 2005). Mate (1989) described movements of a satellite-tagged, rehabilitated long-finned pilot whale released off Cape Cod that traveled roughly 7,600 km (4,101 NM) during the three months of the tag's operation. Daily movements of up to 234 km (126 NM) were documented. Deep diving occurred mainly at night. Tagged long-finned pilot whales in the Ligurian Sea were also found to make their deepest dives (up to 648 m [2,126 ft]) after dark (Baird et al., 2002). Two rehabilitated juvenile long-finned pilot whales released south of Montauk Point, New York made dives in excess of 26 min (Nawojchik et al., 2003). Mean dive duration for a satellite-tracked long-finned pilot whale in the Gulf of Maine ranged from 33 to 40 sec., depending upon the month (July through September) (Mate et al., 2005).

Acoustics and Hearing – Pilot whale sound production includes whistles and echolocation clicks. Short-finned pilot whale whistles and clicks have a dominant frequency range of 2 to 14 kHz and 30 to 60 kHz (Ketten, 1998; Richardson et al., 1995), respectively, at an estimated source level of 180 dB re 1 µPa-m peak (Fish and Turl, 1976; Ketten, 1998). Rendell and Gordan (1999) recorded vocalizations from a group of approximately 50 long-finned pilot whales in the Ligurian Sea in conjunction with the presence of military sonar signals, which facilitated an examination of this species short-term response to external sound sources. Whistle production was examined in relation to sonar pulses: frequency ranged from 4.1 to 8.7 kHz with a mean duration of .93 s, and showed varying contour patterns spectrographically (Rendell and Gordon, 1999). Preliminary results from these data suggest that certain whistles were associated with sonar signals; however, the functional meaning of how these signals might be correlated to external sonar is unclear.Long-finned pilot whales have been shown to modify their whistle characteristics in the presence of sonar transmissions in the Ligurian sea (Rendell and Gorden, 1999).

There are no hearing data available for either pilot whale species. However, the most sensitive hearing range for odontocetes generally includes high frequencies (Ketten, 1997).

Distribution **–** Long-finned pilot whales are distributed in subpolar to temperate North Atlantic waters offshore and in some coastal waters; however, strandings of long-finned pilot whales have been recorded as far south as South Carolina (Waring et al., 2008). Generally, long-finned pilot whales appear to concentrate during winter along the continental shelf break primarily between Cape Hatteras and Georges Bank (Waring et al., 1990).

The short-finned pilot whale usually ranges between of 40°N or south of 40°S (Bernard and Reilly 1999) and is common south of Cape Hatteras (Caldwell and Golley, 1965; Irvine et al., 1979).

The apparent ranges of the two pilot whale species overlap in shelf/shelf-edge and slope waters of the northeastern U.S. between 35°N and 38° to 39°N (New Jersey to Cape Hatteras, North Carolina) (Payne and Heinemann, 1993); however, incidents of strandings of short-finned pilot whales as far north as Block Island, Rhode Island, and Nova Scotia indicate that area of overlap may be larger than previously thought (Waring et al., 2008).

Pilot whales concentrate along the continental shelf break from during late winter and early spring north of Cape Hatteras (CETAP, 1982; Payne and Heinemann, 1993). This corresponds to a general movement northward and onto the continental shelf from continental slope waters (Payne and Heinemann, 1993). From June through September, pilot whales are broadly distributed over the continental shelf (Payne et al., 1990b), with the greater percentage of pilot whale sightings along the continental shelf break in the northeastern portion of Georges Bank and onto the Scotian Shelf. From May through October, pilot whales predominantly occur on the northern edge of central Georges Bank (Payne et al., 1990b). Movements from June through September continue northward into the Gulf of Maine and into Canadian waters. From September through December, the largest concentrations of pilot whales occur along the southwestern edge of Georges Bank. By December, many pilot whales have already moved offshore and southward (Payne and Heinemann, 1993).

Short-finned pilot whales seem to move from offshore to continental shelf break waters and then northward to approximately 39º N, east of Delaware Bay during summer (Payne and Heinemann, 1993). Sightings coalesce into a patchy continuum and, by December, most short-finned pilot whales occur in the mid-Atlantic slope waters east of Cape Hatteras (Payne and Heinemann, 1993). Although pilot whales appear to be seasonally migratory, sightings indicate common year-round residents in some continental shelf areas, such as the southern margin of Georges Bank (CETAP, 1982; Abend and Smith, 1999). Only the short-finned pilot whale is known in the GOMEX.

Atlantic Ocean, Offshore of the Southeastern United States

Pilot whales are considered shelf-edge species. The short-finned pilot whale is considered to be a more tropical species, common south of Cape Hatteras, North Carolina; however, strandings have been reported as far north as Rhode Island. Pilot whales are likely to occur in the VACAPES OPAREA in spring, summer, and fall. Both species of pilot whales are likely to occur year-round in waters on the continental shelf, over the shelf break, and into deeper waters past the eastern boundary of the VACAPES OPAREA.

Identifying the species of pilot whale is difficult at sea, and the CHPT OPAREA is located in the overlap area for the ranges of both pilot whale species. North of Cape Hatteras, pilot whales are likely to occur in waters year-round on the continental shelf, over the shelf-edge, and into deep water past the CHPT OPAREA. Pilot whales may occur from the shore to across the continental shelf.

Pilot whales are likely to occur in the JAX/CHASN OPAREA from the vicinity of the continental shelf break into waters seaward of the OPAREA boundary. Pilot whales may occur between the shore and the vicinity of the continental shelf break for all seasons. This is based upon sightings of pilot whales on the continental shelf (including waters quite close to shore) to the north of the JAX/CHASN OPAREA.

Atlantic Ocean, Offshore of the Northeastern United States

Pilot whales may occur year-round, in waters extending from the continental shelf to the continental rise, from the Bay of Fundy south towards the VACAPES OPAREA. In general, spring and summer have the greatest occurrences of pilot whales in the Northeast.

In the wintertime, pilot whales may occur over the continental shelf and slope waters from Jeffreys Bank and south towards the VACAPES OPAREA. Pilot whales seem to primarily occur in the vicinity of the continental slope waters along the southern flank of Georges Bank south towards the VACAPES OPAREA and within Cape Cod Bay. The short-finned pilot whale is considered to be rare in the Northeast OPAREAs; the species boundary is considered to be in the New Jersey to Cape Hatteras area (Payne and Heinemann, 1993).

In the springtime, pilot whales occur primarily over the continental shelf and slope, in waters extending from Jordan Basin and the Scotian Shelf south towards the VACAPES OPAREA. Sightings are common in Georges Bank during this time of year (Payne and Heinemann, 1993). During this season, greater concentrations of pilot whales may be found just south of the New England Sea Mount Chain and south towards the VACAPES OPAREA, in the vicinity of the continental slope.

In the summertime, pilot whales are generally found in the waters of the continental shelf seaward from the Bay of Fundy and the Scotian Shelf and south towards the VACAPES OPAREA. Pilot whales seem to primarily occur in the vicinity of the continental shelf break in waters from the Scotian Shelf south towards the VACAPES OPAREA, and along the northern flank of Georges Bank. During this season, a greater concentration of pilot whales may occur at the mouth of the Northeast Channel.

In the fall, pilot whales may occur in waters over the continental shelf and slope, from the Bay of Fundy and the Scotian Shelf and south towards the VACAPES OPAREA. During this season, pilot whales may be found in greater concentrations near the western tip of Georges Basin, with the greatest concentrations found south near the VACAPES OPAREA, in the vicinity of the continental slope.

GOMEX

As noted by Jefferson and Schiro (1997), the identifications of many pilot whale specimen records in the GOMEX, and most or all sightings, have not been unequivocally shown to be of the short-finned pilot whale. There are no confirmed records of long-finned pilot whales in the GOMEX (Würsig et al., 2000). Based on known distribution and habitat preferences of pilot whales, it is assumed that all of the pilot whale records in the northern GOMEX are of the short-finned pilot whale (Jefferson and Schiro, 1997; Würsig et al., 2000).

There is a preponderance of pilot whales in the historical records for the northern Gulf. Pilot whales, however, are less often reported during recent surveys, such as GulfCet (Jefferson and Schiro, 1997; Würsig et al., 2000). The reason for this apparent decline is not known, but Jefferson and Schiro (1997) suggested that abundance or distribution patterns might have changed over the past few decades, perhaps due to changes in available prey species which was noted off Catalina Island, California (Shane, 1994).

Mullin and Hansen (1999) noted that pilot whales are sighted almost exclusively west of the Mississippi River. There are a large number of historical strandings on the western coast of Florida and in the Florida Keys.

During the winter, there are no known seasonal changes in occurrence patterns for this species in the Gulf.

Spring is the season with the most survey effort. Pilot whales occur in areas of steep bottom topography in most of the western Gulf, as well as in the region of the Mississippi River Delta and southwest of the Florida Keys.

In the summer, this species occurs in areas of steep bottom topography in most of the western Gulf, in the region of the Mississippi River Delta, and southwest of the Florida Keys. The pattern is similar in many respects to that predicted for spring, with some shifts in areas of concentration that might be indicative of temporal (yearly) differences in survey effort and sighting conditions.

In the fall, occurrence may be concentrated in locations around the shelf break, in particular, south of the Mississippi River Delta, over the continental slope. This is a time of a year with less survey effort than some other seasons (specifically spring and summer); therefore, it is possible that occurrence would be shown over a larger area if there was more survey effort during this time of year.

3.6.1.2.21 Harbor Porpoise (*Phocoena phocoena*)

***Description* –** Harbor porpoises are the smallest cetaceans in the North Atlantic with a maximum length of 2 m (7 ft) (Jefferson et al., 1993). The body is stocky, dark gray to black dorsally and white ventrally. There may be a dark stripe from the mouth to the flipper. The head is blunt, with no distinct beak. The flippers are small and pointed and the dorsal fin is short and triangular, located slightly behind the middle of the back.

***Status* –** There are four proposed harbor porpoise populations in the western North Atlantic: Gulf of Maine and Bay of Fundy, Gulf of St. Lawrence, Newfoundland, and Greenland stocks (Gaskin, 1992). The best estimate of abundance for the Gulf of Maine and Bay of Fundy stock is 89,054 individuals (Waring et al., 2008).

Diving Behavior – Harbor porpoises make brief dives, generally lasting less than 5 min (Westgate et al., 1995). Tagged harbor porpoise individuals spend 3 to 7 percent of their time at the surface and 33 to 60 percent in the upper 2 m (7 ft) (Westgate et al., 1995; Read and Westgate, 1997). Average dive depths range from 14 to 41 m (46 to 135 ft) with a maximum known dive of 226 m (741 ft) and average dive durations ranging from 44 to 103 sec (Westgate et al., 1995). Westgate and Read (1998) noted that dive records of tagged porpoises did not reflect the vertical migration of their prey; porpoises made deep dives during both day and night.

Acoustics and Hearing – Harbor porpoise vocalizations include clicks and pulses (Ketten, 1998), as well as whistle-like signals (Verboom and Kastelein, 1995). The dominant frequency range is 110 to 150 kHz, with source levels between 135 and 205 dB re 1 μPa-m (Ketten, 1998) (Villadsgaard, 2007). Echolocation signals include one or two low-frequency components in the 1.4 to 2.5 kHz range (Verboom and Kastelein, 1995). While harbor porpoises do not produce whistle sounds, studies have shown that they do produce a variety of social and communicative signals that can be described as grunts, whoops, and bleats. These signals can range up to 2 kHz (Verboom and Kastelein, 2003).

A behavioral audiogram of a harbor porpoise indicated the range of best sensitivity is 8 to 32 kHz (Andersen, 1970); however, auditory-evoked potential (AEP) studies showed a much higher frequency of approximately 125 to 130 kHz (Bibikov, 1992). More recent psycho-acoustic studies found the range of best hearing to be 16 to 140 kHz, with a reduced sensitivity around 64 kHz (Kastelein et al., 2002). Maximum sensitivity occurs between 100 and 140 kHz (Kastelein et al., 2002).

Distribution **–** Harbor porpoises occur in subpolar to cool-temperate waters in the North Atlantic and Pacific (Read, 1999). Off the northeastern United States, harbor porpoise distribution is strongly concentrated in the Gulf of Maine/Georges Bank region, with more scattered occurrences to the mid-Atlantic (CETAP, 1982; Northridge, 1996). Stranding data indicate that the southern limit is northern Florida (Polacheck, 1995; Read, 1999). Genetic evidence suggests limited trans-Atlantic movement (Rosel et al., 1999a).

From July through September, harbor porpoises are concentrated in the northern Gulf of Maine and southern Bay of Fundy, generally in waters less than 150 m (492 ft) deep (Palka, 1995), with a few sightings in the upper Bay of Fundy and on the northern edge of Georges Bank (Palka, 2000). From October through December, harbor porpoise densities are widely dispersed from New Jersey to Maine, with lower densities to the north and south of this region (NMFS, 2001a). Most harbor porpoises are found on the continental shelf, with some sightings in continental slope and offshore waters (Westgate et al., 1998; Waring et al., 2007). During this time, sightings are concentrated in the southwestern and northern Gulf of Maine, as well as in the Bay of Fundy (CETAP, 1982). From January through March, intermediate densities of harbor porpoises can be found in waters off New Jersey to North Carolina, and lower densities are found in waters off New York to New Brunswick, Canada (NMFS, 2001a). The New Jersey shore and approaches to New York harbor may represent an important January to March habitat (Westgate et al., 1998). A satellite tagged harbor porpoise, "Gus", was rehabilitated and released off the coast of Maine and followed the continental slope south to near Cape Hatteras between January and March of 2004 (WhaleNet, 2004). During this time of year, significant numbers of porpoises occur along the mid-Atlantic shore from New Jersey to North Carolina, where they are subject to incidental mortality in a variety of coastal gillnet fisheries (Cox et al., 1998; Waring et al., 2007). Mid-Atlantic porpoise bycatches occur from December through May (Waring et al., 2007). Data indicate that only juvenile harbor porpoises are present in nearshore waters of the mid-Atlantic during this time (Cox et al., 1998). Harbor porpoises are not tied to shallow, nearshore waters during winter, as evidenced by a harbor porpoise caught in a pelagic drift net off North Carolina (Read et al., 1996). A largely offshore harbor porpoise distribution during winter explains the paucity of sightings in the Bay of Fundy and Gulf of Maine (CETAP, 1982). However, genetic data from mid-Atlantic stranded and by-caught porpoises show them to be a mixture of animals from different stocks, rather than simply migrants from the Gulf of Maine and Bay of Fundy stock (Rosel et al., 1999b).

A noteworthy unusual mortality event took place between January 1, 2005 and March 28, 2005 during which 38 harbor porpoises stranded along the coast of North Carolina (Hohn et al., 2006; MMC, 2006a). Most of the stranded individuals were calves and many were emaciated, indicating that the harbor porpoises had difficulty finding food (MMC, 2006a).

Atlantic Ocean, Offshore of the Southeastern United States

The southern limit for this species in the western North Atlantic is northern Florida, based on stranding information. During the winter and spring, there is a concentration of recorded by-catch and strandings in the vicinity of Cape Hatteras, most probably due to catches in gillnets and driftnets. The harbor porpoise is restricted to cool waters, where aggregations of prey are concentrated. They are seldom found in waters warmer than 17°C (64°F). In the VACAPES OPAREA, this species primarily occurs on the continental shelf, but there are also recorded sightings in offshore waters. The harbor porpoise may occur in the fall, winter, and spring from the 2,000-m (6,561.7-ft) isobath to eastward of the boundary of the VACAPES OPAREA. During winter, high concentrations of harbor porpoises are likely in the area from the coastline to the 200-m (656.2-ft) isobath, based on the increase in sighting records of harbor porpoise in this area during winter.

Harbor porpoises are likely to occur only in the northwestern tip of the CHPT OPAREA (with the southern boundary of its occurrence being the Gulf Stream) in the fall and winter. Taken into consideration was the possibility that some individual harbor porpoises might make their way into the northern portion of this OPAREA at that time of the year. There are only some stranding records for south of the Virginia/Maryland border during the spring and fall, and no sightings or by-catch records. During summer, harbor porpoises are concentrated in the northern Gulf of Maine and lower Bay of Fundy region and are not likely to occur as far south as the CHPT OPAREA.

Atlantic Ocean, Offshore of the Northeastern United States

Harbor porpoises occur year-round throughout the northern region of the Northeast OPAREAs, primarily in continental shelf waters. The overall distribution seems to be concentrated in the Gulf of Maine (CETAP, 1982; Northridge, 1996). The general distribution seems to shift further north in summer and fall.

In the wintertime, harbor porpoises occur in the continental shelf waters, extending from the northern coast of Maine and south towards the VACAPES OPAREA. Most of the occurrence records are in the Gulf of Maine. During winter (January through March), intermediate densities of harbor porpoises can be found in waters off New Jersey to North Carolina, and lower densities are found in waters off New York to New Brunswick, Canada (NMFS, 2001a).

In the springtime, harbor porpoises generally occur over the continental shelf, in waters extending from the Bay of Fundy to off the coast of Maryland. The distribution of the occurrence records seem to be concentrated in the Gulf of Maine and over Georges Bank.

In the summertime, harbor porpoises primarily occur in waters over the continental shelf, extending from the Bay of Fundy and the Scotian Shelf to off the northern coast of New Jersey. The overall distribution of occurrences seems to shift to the northern regions, with a few scattered occurrences found near Georges Bank. During this season, the harbor porpoise may occur in greater concentrations near the coasts of southern New Brunswick and northern Maine.

In the fall, harbor porpoises may occur in waters over the continental shelf, extending from the Bay of Fundy. The general distribution occurs primarily in the Gulf of Maine. During this season, harbor porpoises may occur in greater concentrations near the southern coast of New Brunswick.

GOMEX

The harbor porpoise is not expected to occur within the GOMEX.

3.6.1.3 Pinnipeds

The composition and distribution of the seal population in the northeastern United States has become increasingly complex. The northern part of the U.S. eastern seaboard has experienced a significant increase in stranded ice seals since the late 1980s (Kraus and Early, 1995; McAlpine and Walker, 1999; Sadove et al., 1999; Slocum et al., 1999,2003). In the winter, there are harp and hooded seals in the Gulf of Maine in numbers never before observed. McAlpine and Walker (1999) speculated that the cause for this increase may be due to the collapsed fish stocks that can no longer support the currently large seal populations, forcing seals to move to less optimal feeding grounds further south. Alteration in the extent and productivity of ice-edge systems may affect the density of important ice-associated prey of pinnipeds, such as Arctic cod (Tynan and DeMaster, 1997).

Pinnipeds occur primarily close to shore in the northern part of the western North Atlantic, although they have been observed some distance from shore during spring in the vicinity of the Great South Channel. The seals commonly occurring in the waters of the Northeast use the numerous islands and ledges to haul out of the water where they rest, pup, and molt. Although there are a few sporadic sighting and bycatch records from MAB waters, pinnipeds do occur in the southern portion of the U.S. Northeast as indicated by the number of stranding records from New York and New Jersey. While more pinniped strandings occur in the winter and spring months, the number of seals sighted at sea and in coastal waters of Maine and Massachusetts is highest in spring and summer. The lower number of pinniped sightings in the fall and winter may be due to the decreased survey effort during those time periods.

3.6.1.3.1 Hooded Seal (*Cystophora cristata*)

Description – Hooded seals are large; adult males are approximately 2.6 m (8 ft) in length and weigh on average 300 kg (661 lb), with some individuals reaching over 400 kg (882 lb) (Kovacs, 2002). Females are smaller, measuring approximately 2 m (7 ft) and weighing an average of 200 kg (441 lb) (Kovacs, 2002). Hooded seal pups are blue-black on their backs and silver-gray on their bellies; hence, the common name “blue-back” for the pups. Adults are gray to blue-black in color with an overlay pattern of black mottling (Reeves and Ling, 1981). The face is black to behind the eyes; the flippers are also dark (Reeves and Ling, 1981). The most unique feature of this species is the prominent two-part nasal ornament of sexually mature males that gives the species its common name; it is used to display to females and to other males during the breeding season. When relaxed, this nasal appendage hangs as a loose, wrinkled sac over the front of males’ noses. However, when they clamp their nostrils shut and inflate the sac, it becomes a large, tight, bilobed “hood” that covers the front of the face and top of the head. Adult males also have a very elastic nasal septum that they can extrude through one of their nostrils as a membranous pink balloon.

Status **–** The world's hooded seal population consists of three separate stocks that are identified with a specific breeding site: Western North Atlantic (Newfoundland/Labrador and Gulf of St. Lawrence), eastern Greenland ("West Ice"), and Davis Strait (Stenson et al., 1996; Waring et al., 2007). The Western North Atlantic stock is divided into two breeding herds: the Front herd breeds off the coast of Newfoundland and Labrador while the Gulf herd breeds in the Gulf of St. Lawrence (Waring et al., 2007). The other two stocks represent separate breeding herds. Recent genetic studies indicate that the world's hooded seals comprise a single panmictic genetic population; therefore, the four breeding herds are not genetically isolated (Coltman et al., 2007).

The best estimate of abundance for western North Atlantic hooded seals is 592,100 (Waring et al., 2007). There are no recent pup counts to assess the current population size in U.S. waters (Waring et al., 2007). Dramatic increases in hooded seal numbers on Sable Island have occurred concurrently with the recent increases of extralimital occurrences along the northeastern United States (Lucas and Daoust, 2002).

Diving Behavior – Hooded seals feed primarily on deepwater fishes and squids (Reeves and Ling, 1981; Campbell, 1987; Kovacs, 2002). Adult hooded seals can dive to depths of over 1,000 m and remain underwater for nearly an hour (Folkow and Blix, 1999).

Acoustics and Hearing – Hooded seals have a diverse vocal repertoire (Ballard and Kovacs, 1995). Both males and females, as well as different age classes, have been recorded producing sounds (Ballard and Kovacs, 1995). Hooded seal calls are primarily aerial but can be produced underwater. Underwater sounds have most of their energy below 4 kHz and include "grungs," whoops, moans, trills, knocks, snorts, and buzzes (Terhune and Ronald, 1973; Ballard and Kovacs, 1995). Males produce low-frequency sounds in air that coincide with dominance displays utilizing the nasal appendage. Vester et al. (2003) recorded ultrasonic clicks produced by hooded seals, with a frequency range of 66 to 120 kHz and average source levels of 143 dB re 1 μPa-m in conjunction with hunting fish.

There are no direct measurements of the hearing abilities of the hooded seal (Kastelein, 2007; Southall, 2007). Composite Arctic seal hearing data is considered here in the absence of such information as recommended by NMFS (Southall, 2007). The range of underwater hearing for the ringed seal (*Pusa hispida*) ranges from 2.8 to 45 kHz, while in air they hear best in the range of 3 to 10 kHz (Terhune and Ronald, 1975). The harp seal's (*Pagophilus groenlandicus*) underwater hearing range is from 1 to 40 kHz, with increased sensitivity at 2 and 22.9 kHz (measured from 0.76 to 100 kHz) (Terhune and Ronald, 1972). In air, they hear from 1 to 32 kHz with greatest sensitivity at 29 dB at 4 kHz (Terhune and Ronald, 1971).

Distribution **–** Hooded seals inhabit the pack ice zone of the North Atlantic from the Gulf of St. Lawrence, Newfoundland, and Labrador in the west to the Barents Sea (Campbell, 1987). Hooded seals are not common south of the Gulf of St. Lawrence (Lucas and Daoust, 2002). Hooded seals are concentrated in four discrete areas during the breeding season: in the "Front" off the coasts of Newfoundland and Labrador, in the Gulf of St. Lawrence, in the Davis Strait, and on the "West Ice" around Jan Mayen Island off eastern Greenland (Jefferson et al., 2008).

After the breeding season, hooded seal adults feed along the continental slope off southern Newfoundland and the southern Grand Banks for roughly 20 days before moving northward across the Labrador Basin to west Greenland in June (Bowen and Siniff, 1999). Thereafter, individuals move into traditional molting areas on the southeast Greenland coast, near the Denmark Strait, or in a smaller patch along the northeast Greenland coast (Kovacs, 2002). After the molt in late June and August, hooded seals disperse. Some individuals move south and west around the southern tip of Greenland and then north along western Greenland. Others move to the east and north between Greenland and Svalbard during late summer and early fall (Kovacs and Lavigne, 1986). Not much is known about the activities of hooded seals during the remainder of the year from molting until they reassemble in February for breeding (Campbell, 1987).

The range of hooded seals may be considerably influenced by changes in ice cover and climate (Campbell, 1987; Johnston et al., 2005). Hooded seals can make extensive movements and show a tendency toward wandering, with extralimital sightings documented as far south as Puerto Rico and the Virgin Islands (Mignucci-Giannoni and Odell, 2001; Mignucci-Giannoni and Haddow, 2002). Most extralimital sightings occur between late January and mid-May off the northeastern United States and during summer and fall off the southeastern United States and in the Caribbean Sea (McAlpine et al., 1999a, 1999b; Harris et al., 2001; Mignucci-Giannoni and Odell, 2001). These extralimital animals have primarily been immature individuals, although adults are occasionally reported, including an incidence of pupping in Maine (Richardson, 1975). Between January and September 2006, a total of 55 hooded seals stranded along the East Coast and as far south as the U.S. Virgin Islands; the majority of these strandings occurred during July, August, and September (NOAA, 2006f).

Atlantic Ocean, Offshore of the Southeastern United States

Hooded seals are one of the two species of ice seals that are recognized as great wanderers but rarely venture into the VACAPES or CHPT regions. There are three records for hooded seals for North Carolina. Although they appear in places far from their normal breeding and foraging range, hooded seals are not expected to occur within these OPAREAs. There are five records for hooded seals for Georgia and Florida; the majority of these records are for July and August. Hooded seals are not expected to occur in JAX/CHASN OPAREA.

Atlantic Ocean, Offshore of the Northeastern United States

Hooded seals may occur throughout the Northeast OPAREAs, from the northern coast of Maine to the southern coast of Delaware. In general, the occurrence of hooded seals is greatest during winter.

GOMEX

The hooded seal is not expected to occur within the GOMEX.

3.6.1.3.2 Harp Seal (*Pagophilus groenlandicus*)

Description – These medium-sized phocid seals reach a size of 1.8 m (6 ft) and 130 kg (287 lb); females are slightly smaller (Lavigne, 2002). Adults typically have a light gray pelage, a black face, and a black saddle behind the shoulders. This black saddle extends in a lateral band on both sides toward the pelvis, forming a pattern that resembles a harp. Some adults are sparsely spotted, with the harp pattern not completely developed (Reeves et al., 2002b). Newborn pups, called “whitecoats” have a long, white coat that is replaced soon after weaning (at about 3 to 4 weeks) by a short, silver pelage with scattered, small dark spots.

Status – The harp seal is the most abundant pinniped in the western North Atlantic Ocean (Hammill and Stenson, 2005). The estimate based on a 2004 for the western North Atlantic stock is 5.5 million seals (Waring et al., 2008). The total population of harp seals is divided among three separate breeding stocks in the White Sea, the Greenland Sea between Jan Mayen and Svalbard, and the western North Atlantic (Reeves et al., 2002b). The western North Atlantic stock is the largest; it is divided into two breeding herds: The “Front” herd breeds off the coast of Newfoundland and Labrador, while the “Gulf” herd breeds near the Magdalen Islands (Reeves et al., 2002b; Waring et al., 2008).

In addition to subsistence hunts in the Canadian Arctic and Greenland, harp seals are harvested commercially in the Gulf of St. Lawrence and off the coast of northeast Newfoundland and Labrador (DFO, 2003).

Diving Behavior – Most foraging occurs at depths of less than 90 m (295 ft), although dives as deep as 568 m (1,864 ft) have been recorded (Lydersen and Kovacs, 1993; Folkow et al., 2004).

Acoustics and Hearing – The harp seal’s vocal repertoire consists of at least 27 underwater and two aerial call types (Serrano, 2001). Harp seals are most vocal during the breeding season (Ronald and Healey, 1981). Serrano (2001) found that calls of low frequency and with few pulse repetitions were predominantly used outside the breeding season, while calls of high frequency and with a high number of pulse repetitions predominated in the breeding season. Terhune and Ronald (1986) measured source levels of underwater vocalizations of 140 dB re 1 μPa-m. Vester et al. (2001) recorded ultrasonic clicks with a frequency range of 66 to 120 kHz, with the main energy at 93±22 kHz and average source levels of 143+ dB re 1 μPa-m in conjunction with live fish hunting.

Behavioral audiograms have been obtained for harp seals (Terhune and Ronald, 1972). The harp seal’s ear is adapted for better hearing underwater. The harp seal’s underwater hearing range is from 1 to 40 kHz, with increased sensitivity at 2 and 22.9 kHz (Terhune and Ronald, 1972). In air, hearing is irregular and slightly insensitive with the audiogram being generally flat; harp seals hear from 1 to 32 kHz with greatest sensitivity at 4 kHz (Terhune and Ronald, 1971).

Distribution – Harp seals are distributed in the pack ice of the North Atlantic and Arctic oceans, from Newfoundland and the Gulf of St. Lawrence to northern Russia (Reeves et al., 2002b). Most of the western North Atlantic harp seals congregate off the east coast of Newfoundland-Labrador (the Front) to pup and breed. The remainder (the Gulf herd) gather to pup near the Magdalen Islands in the Gulf of St. Lawrence (Ronald and Dougan, 1982). Females reach the breeding grounds at the Gulf of St. Lawrence by mid-February and at the Front by early March (Ronald and Dougan, 1982). During the early period of pupping, males are found in separate concentrations. Once mating has ended, harp seals move to more northerly ice in preparation for the annual molt, leaving the newly weaned pups at the breeding grounds. In April, juveniles of both sexes and adult males form dense molting concentrations on the pack ice at the Front. Adult females join these concentrations in late April. By mid-May, most of the population follows the retreating ice edge north. After molting in April, harp seals leave the drifting ice and move north along the east coast of Canada toward their Arctic summering grounds, spending this time in the open water among the ice floes of the Eastern Canadian Arctic or along the west coast of Greenland. Harp seals arrive in June when capelin (an important prey item) concentrate to spawn (Bowen and Siniff, 1999). With the formation of new ice in September, harp seals begin their southward movements along the Labrador coast, usually reaching the entrance to the Gulf of St. Lawrence by early winter (DFO, 2005). There, the population then splits into the two breeding groups, one moving into the Gulf of St. Lawrence and the other remaining off the coast of Newfoundland. During January and February, adult harp seals disperse widely throughout the Gulf of St. Lawrence and over the continental shelf off Newfoundland to fatten in preparation for reproduction. Not all juvenile harp seals make the southward mass movement; some remain in the Arctic along the southwestern coast of Greenland (Bowen and Siniff, 1999). The large-scale movements of harp seals represent an annual round trip of more than 4,000 km (2,158 NM) (Bowen and Siniff, 1999).

The number of sightings and strandings of harp seals off the northeastern U.S. has been increasing (McAlpine and Walker, 1990; Rubinstein, 1994; Stevick and Fernald, 1998; McAlpine et al., 1999a; McAlpine et al., 1999b; Harris et al., 2002). These occurrences are usually during January through May (Harris et al., 2002). Harp seals occasionally enter the Bay of Fundy; however, McAlpine and Walker (1999) suggested that winter ocean surface currents might limit the probability of extralimital occurrences into this bay.

Atlantic Ocean, Offshore of the Southeastern United States

On occasion, a harp seal wanders south of the normal feeding and breeding areas off Newfoundland during the wintertime. There is a record of an adult harp seal that was found in March, 1945 at Cape Henry, Virginia (Goodwin, 1954). A few of these wandering seals stay into the summer months in southern waters (DFO, 2005). Strandings outside of the normal range occur between early February and late May and involve animals of both sexes and various ages. Harp seals are not expected to occur within the VACAPES, CHPT, or JAX/CHASN OPAREAs.

Atlantic Ocean, Offshore of the Northeastern United States

Harp seals may occur in the Northeast OPAREAs from the northern coast of Maine to the southern coast of Delaware during winter and spring and from southern coast of Maine to Long Island during fall. Occurrence information is derived almost solely from the stranding record. There is only one occurrence record of harp seals near the southern coast of Maine during summer.

GOMEX

The harp seal is not expected to occur within the GOMEX.

3.6.1.3.3 Gray Seal (*Halichoerus grypus*)

Description – Gray seals are large and robust; adult males can reach 2 m (7 ft) in length and weigh 310 kg (683 lb) (Jefferson et al., 1993). The sexes are sexually dimorphic; males are up to three times larger than females (Bonner, 1981). The species name *grypus* means "hook-nosed", referring to the Roman nose profile of the adult male (Hall, 2002). In Canada, the gray seal is often referred to as the 'horse-headed" seal due to the elongated snout of the males (Lesage and Hammill, 2001). The head has a wide muzzle, and the nostrils form a distinctive, almost "W" shape (Jefferson et al., 1993). Pelage color and pattern are individually variable, with most gray seals seen in shades of gray, slightly darker above than below (Jefferson et al., 1993). There are usually numerous irregular blotches and spots on the back. Males are generally more uniformly dark when mature whereas females exhibit the more distinct markings on the fur (Hall, 2002).

Status – Next to harbor seals, gray seals are the most commonly sighted seal in the northeastern United States. There are at least three populations of gray seal in the North Atlantic Ocean: eastern North Atlantic, western North Atlantic, and Baltic (Boskovic et al., 1996). The western North Atlantic stock is equivalent to the eastern Canada breeding population (Waring et al., 2008). There are two breeding concentrations in eastern Canada: one at Sable Island and the other on the pack ice in the Gulf of St. Lawrence. These two breeding groups are treated as separate populations for management purposes (Mohn and Bowen, 1996). There are an estimated 195,000 gray seals in Canada (DFO, 2003). The herd on Sable Island is thought be growing and may have more than doubled in number, but the Gulf of St. Lawrence population is declining (Bowen et al., 2003). This decline has been attributed to sharp decline in the quantity of suitable ice breeding habitat in the southern Gulf of St. Lawrence possibly due to climate change (Hammill et al., 2003).

There is no population estimate available for the western North Atlantic population of gray seals, nor is there an estimate for the number of individuals occurring in U.S. waters. The estimates that are available represent disparate temporal and spatial scales (and thus cannot be combined in any useful manner) and many of them are unpublished. However, the total number of gray seals in U.S. waters is thought to be increasing (Waring et al., 2008).

Diving Behavior – While at sea, and even when traveling, gray seals do not swim at the water's surface (Thompson and Fedak, 1993). Gray seals are able to dive to depths up to 400 m (1,312 ft); however, the majority of dives are only 40 to 100 m (131 to 328 ft) (Goulet et al., 2001; Lesage and Hammill, 2001). The maximum dive duration is just over 9 min (Lydersen et al., 1994). In areas with deeper waters, gray seals are reported to dive for as long as 32 min (Thompson and Fedak, 1993; Goulet et al., 2001). Surface intervals between dives are most often 1.2 min (Boyd and Croxall, 1996).

Acoustics and Hearing – Asselin et al. (1993) classified all gray seal in-air vocalizations into seven call types. The majority of calls consisted of guttural "rups" and "rupes", ranging from 0.1 to 3 kHz, or low-frequency growls ranging from 0.1 to 0.4 kHz (Asselin et al., 1993). Ridgway and Joyce (1975) examined six young gray seals as part of a larger EEG telemetry study. In-air and underwater measures of hearing were made for gray seals which indicated AEP thresholds at selected frequencies from 1 to 150 kHz in water and from 0.2 to 30 kHz in air (Ridgway and Joyce, 1975). Ketten (1998) determined that most pinnipeds species have peak sensitivities between 1 to 20 kHz.

Distribution – The gray seal is found throughout temperate and subarctic waters on both sides of the North Atlantic Ocean (Davies, 1957). In the western North Atlantic Ocean, the gray seal population is centered in the Canadian Maritimes, including the Gulf of St. Lawrence and the Atlantic coasts of Nova Scotia, Newfoundland, and Labrador. The largest concentrations are found in the southern half of the Gulf of St. Lawrence (where most seals breed on ice) and around Sable Island (where most seals breed on land) (Davies, 1957; Hammill and Gosselin, 1995; Hammill et al., 1998).

Gray seals range south into the northeastern United States, with strandings recorded from as far south as North Carolina (Hammill et al., 1998; Waring et al., 2007). Small rookeries have been observed on several isolated islands along the central coast of Maine and in Nantucket Sound (Andrews and Mott, 1967; Rough, 1995; Waring et al., 2007). Spring and summer sightings off Maine are primarily on offshore ledges of the central coast (Richardson, 1976). In the late 1990s, a breeding population of at least 400 animals was documented year-round on outer Cape Cod and Muskeget Island (Barlas, 1999; Waring et al., 2004). Hoover et al. (1999) reported sighting as many as 30 adult gray seals at one haul out site in New York. There are also gray seal sightings and strandings reported from Long Island Sound. From December to February, gray seals in the western North Atlantic Ocean aggregate into two main breeding colonies located on Sable Island and in the southern Gulf of St. Lawrence. Post-breeding, gray seals disperse widely; they remain offshore until the spring molt (May to June) (Rough, 1995; Lesage and Hammill, 2001). After the molt is completed, there is a second dispersal; the destination of these dispersals off eastern Canada is varied and depends on the originating population (Sable Island versus non-Sable Island). In November to December, gray seals return to the southern Gulf of St. Lawrence or to Sable Island for the breeding season. Some gray seals found breeding in the northeastern United States bear brands and tags indicating that they had been born on Sable Island (Wood et al., 2003).

Atlantic Ocean, Offshore of the Southeastern United States

Gray seals occur from southern New England to Labrador, but the highest concentration of this species is centered in the Sable Island region off Nova Scotia. Vagrants have been reported as far south as Virginia. A female pupped at Assateague Island, Virginia, in 1986; another birth was reported at the same place in 1989 (Katona et al., 1993). Gray seals are not expected to occur in the VACAPES, CHPT, or JAX/CHASN OPAREAs.

Atlantic Ocean, Offshore of the Northeastern United States

Gray seals may occur year-round throughout the continental shelf region of the Northeast OPAREAs. The distribution of gray seals is focused primarily in the Bay of Fundy during spring through fall, extending further south during winter and spring. Gray seals range south into the northeastern United States, with strandings reported as far south as North Carolina (Hammill et al., 1998; Waring et al., 2008).

In the wintertime, the general occurrence of gray seals extends from the Bay of Fundy to Delaware, in waters on the continental shelf and near the coast.

In the springtime, gray seals may occur in waters on the continental shelf and near the coast, extending from the Bay of Fundy to Delaware. During this season, gray seals may occur in greater concentrations in the Bay of Fundy.

In the summertime, gray seals generally occur in waters on the continental shelf and near the coast, extending from the Bay of Fundy and the Scotian Shelf to Long Island.

In the fall, gray seals may occur in waters on the continental shelf and near the coast, extending from the Bay of Fundy and the Scotian Shelf to Nantucket, with one record of occurrence near the Delaware coast. During this season, gray seals may occur in greater concentrations in the Bay of Fundy.

GOMEX

The gray seal is not expected to occur within the GOMEX.

3.6.1.3.4 Harbor Seal (*Phoca vitulina concolor*)

Description – The harbor seal (or common seal) is a small- to medium-sized seal. Adult males attain a maximum length of 1.9 m (6.2 ft) and weigh 70 to 150 kg (154 to 331 lb); females reach 1.7 m (5.6 ft) in length and weigh between 60 and 110 kg (132 to 243 lb) (Jefferson et al., 1993). The harbor seal has a dog-like head with nostrils that form a broad V-shape; this is one of the characteristics that distinguish them from immature gray seals (Baird, 2001). Adult harbor seals exhibit considerable variability in the color and pattern of their pelage; the background color is tannish-gray overlaid by small darker spots, ring-like markings, or blotches (Bigg, 1981).

Status – Five subspecies of *Phoca vitulin*a are recognized; *Phoca vitulina concolor* is the form found in the western North Atlantic (Rice, 1998). Harbor seals are the most common and frequently reported seals in the northeastern United States (Katona et al., 1993). Currently, harbor seals along the coast of the eastern United States and Canadian coasts are considered a single population (Waring et al., 2008).

Pressure from hunting bounties in the late 1800s through 1962 resulted in a reduction or complete elimination of harbor seals in heavily exploited areas (Barlas, 1999). A limit to the southward dispersion of harbor seals from Maine rookeries indirectly led to their present seasonal occurrence. During the winter of 1980, a large-scale influenza epidemic in Gulf of Maine harbor seals resulted in a mass mortality event (Geraci et al., 1982). The population has since rebounded (Gilbert et al., 2005).

The best estimate of abundance of harbor seals in the western North Atlantic stock is 99,340 individuals (Waring et al., 2008). An estimated 5,575 harbor seals over-wintered in southern New England in 1999, increasing from an estimated 2,834 individuals in 1981 (Barlas, 1999). Kraus and Early (1995) suggested that the northeastern U.S. population increase could represent increasing southward shifts in wintering distribution.

Diving Behavior – Harbor seals are generally shallow divers. About 50 percent of dives are shallower than 40 m (131 ft) and 95 percent are shallower than 250 m (820 ft) (Gjertz et al., 2001; Krafft et al., 2002; Eguchi and Harvey, 2005). Gjertz et al., 2001 reported dive durations shorter than 10 min, with about 90 percent lasting less than 7 min. However, a tagged harbor seal in Monterey Bay dove as deep as 481 m (1,578 ft) and dive durations for older individuals may be as long as 32 min (Eguchi and Harvey, 2005). Harbor seal pups swim and dive with their mothers, although for shorter periods when mothers are performing bouts of relatively deep dives (Bowen et al., 1999; Jørgensen et al., 2001; Bekkby and Bjørge, 2003).

Acoustics and Hearing – Harbor seal males and females produce a variety of low-frequency in-air vocalizations including snorts, grunts, and growls, while pups make individually unique calls for mother recognition (main energy at 0.35 kHz) (Thomson and Richardson, 1995). Adult males also produce several underwater sounds such as roars, bubbly growls, grunts, groans, and creaks during the breeding season. These sounds typically range from 0.025 to 4 kHz (duration range: 0.1 sec to 11 seconds) (Hanggi and Schusterman, 1994). Hanggi and Schusteman (1994) found that there is individual variation in the dominant frequency range of sounds between different males, and Van Parijs et al. (2003) reported oceanic, regional, population, and site-specific levels of variation (i.e., could represent vocal dialects) between males.

Harbor seals hear nearly as well in air as underwater (Kastak and Schusterman, 1998). Harbor seals are capable of hearing frequencies from 1 to 75 kHz (most sensitive at frequencies between 1 kHz and 60 kHz using behavioral response testing) in water and from 0.25 to 30 kHz in air (most sensitive from 6 to 16 kHz using behavior and auditory brainstem response testing) (Richardson, 1995; Terhune and Turnbull, 1995; Wolski et al., 2003; Southall et al., 2007). Despite the absence of an external ear flap, harbor seals are capable of directional hearing in air, giving them the ability to mask out background noise (Holt and Schusterman, 2007). Underwater sound localization was demonstrated by Bodson et al. (2006). TTS for the harbor seal was assessed at 2.5 kHz and 3.53 kHz (exposure level was 80 and 95 dB above threshold), by Kastak et al. (2005). Data indicated that the range of TTS onset would be between 183 and 206 dB re: $1\mu Pa^2$-s (Kastak et al., 2005).

Distribution – Harbor seals are one of the most widespread pinniped species and are found in subarctic to temperate nearshore waters. Their distribution ranges from the east Baltic west across the Atlantic and Pacific Oceans to southern Japan (Stanley et al., 1996). Harbor seals are year-round residents of eastern Canada (Boulva, 1973) and coastal Maine (Katona et al., 1993; Gilbert and Guldager, 1998). The greatest concentrations of harbor seals in northeastern U.S. waters are found along the coast of Maine, specifically in Machias and Penobscot bays and off Mt. Desert and Swans Islands (Katona et al., 1993).

Harbor seals occur south of Maine from late September through late May (Rosenfeld et al., 1988; Whitman and Payne, 1990; Barlas, 1999; Schroeder, 2000). During winter, the population disperses offshore into the Gulf of Maine south into southern New England, and a portion remains in coastal waters of Maine and Canada. Harbor seals have recently been observed overwintering as far south as New Jersey (Slocum et al., 1999). Payne and Selzer (1989) noted that 75 percent of harbor seals south of Maine are located at haulout sites on Cape Cod and Nantucket Island, with the largest aggregation occurring at Monomoy Island and adjacent shoals. Although harbor seals of all ages and both sexes frequent winter haulout sites south of Maine, many of the over-wintering individuals are immature, suggesting that there might be seasonal segregation resulting from age-related competition for haulout sites near preferred pupping ledges and age-related differences in food requirements (Whitman and Payne, 1990; Slocum and Schoelkopf, 2001). Extralimital occurrences have been observed as far south as Florida (Caldwell and Caldwell, 1969; Waring et al., 2007).

From at least October through December, harbor seal numbers decrease in Canadian waters (Terhune, 1985) but increase three to five fold south of Maine (Rosenfeld et al., 1988). A general southward movement along the Canadian coast and northeastern United States is thought to occur during this period (Rosenfeld et al., 1988). Tagging efforts by Gilbert and Wynne (1985) support this hypothesis. Harbor seals tagged in Nova Scotia and Maine were later resighted in Massachusetts. Prior to pupping, this generalized movement pattern reverses as animals move northward to the coasts of Maine and eastern Canada.

Atlantic Ocean, Offshore of the Southeastern United States

Vagrant harbor seals are occasionally found as far south as the Carolinas and Daytona Beach, Florida. Harbor seals are not expected to occur in the VACAPES, CHPT, or JAX/CHASN OPAREAs. Harbor seals that occur in these areas are apparently young individuals that disperse from the north during the winter.

Atlantic Ocean, Offshore of the Northeastern United States

Harbor seals may occur year round in waters over the continental shelf, extending from the Bay of Fundy to Delaware. Harbor seals occur south of Maine seasonally from late September through late May (Schneider and Payne, 1983; Payne and Schneider, 1984; Rosenfeld et al., 1988; Whitman and Payne, 1990; Barlas, 1999; Hoover et al., 1999; Schroeder and Kenney, 2001).The overall distribution of harbor seals shifts towards the southern region of the Northeast OPAREAs during winter and towards the northern region during summer. Few sighting records exist for harbor seals and all other seal species found in the Northeast OPAREAs due to low sightability of seals during aerial and shipboard surveys.

In the wintertime, harbor seals may be found in waters on the continental shelf and near the coast, extending from the southern coast of New Brunswick to the coast of Delaware.

In the springtime, harbor seals occur primarily in waters on the continental shelf and near the coast, extending from the Bay of Fundy to the southern tip of New Jersey. During this season, harbor seals may occur in greater concentrations off the western coast of Nova Scotia and northern coast of Maine.

In the summertime, harbor seals occur in waters on the continental shelf and near the coast, extending from the Bay of Fundy and Roseway Basin to Delaware. . The greatest concentrations of seals in northeastern U.S. waters are found along the coast of Maine, specifically in Machias and Penobscot bays and off Mt. Desert and Swans islands (Katona et al., 1993).

In the fall, the general occurrence of harbor seals is found in waters on the continental shelf and near the coast, extending from the Bay of Fundy to Delaware.

GOMEX

The harbor seal is not expected to occur within the GOMEX.

3.6.1.4 Sirenians

3.6.1.4.1 West Indian Manatee (*Trichechus manatus*)

Description **–** The West Indian manatee is a rotund, slow-moving animal, which reaches a maximum length of 3.9 m (12.8 ft) (Jefferson et al., 1993). The manatee has a small head, a squarish snout containing two semi-circular nostrils at the front, and fleshy mobile lips. The tail is horizontal, rounded, and paddle-shaped. The body is gray or gray-brown and is covered with fine hairs that are sparsely distributed. The back of larger animals is often covered with distinctive scars from boat strikes (Moore, 1956).

Status **–** West Indian manatees are classified as endangered under the ESA. West Indian manatee numbers are assessed by aerial surveys during the winter months when manatees are concentrated in warm-water refuges. Aerial surveys conducted in February 2006 produced a preliminary abundance estimate of 3,113 individuals (FMRI, 2006). Along Florida's Gulf Coast, observers counted 1,474 West Indian manatees, while observers on the Atlantic coast counted 1,639. In the most recent revision of the West Indian manatee recovery plan, it was concluded that, based upon movement patterns, West Indian manatees around Florida should be divided into four relatively discrete management units or subpopulations, each representing a significant portion of the species' range (USFWS, 2001a). West Indian manatees found along the Atlantic U.S. coast are of the Atlantic Region subpopulation (USFWS, 2001a). The other three subpopulations in Florida are Upper St. Johns River Region, Northwest Region, and the Southwest Region (USFWS, 2001a).

In 1976, critical habitat was designated for the West Indian manatee in Florida (USFWS, 1976). The designated area included all of the West Indian manatee's known range at that time (including waterways throughout about one-third to one-half of Florida) (Laist, 2002). This critical habitat designation has been infrequently used or referenced since it is broad in description, treats all waterways the same, and does not highlight any particular areas (Laist, 2002). There are two types of manatee protection areas in the state of Florida: manatee sanctuaries and manatee refuges (USFWS, 2001, 2002a and 2002b). Manatee sanctuaries are areas where all waterborne activities are prohibited while manatee refuges are areas where activities are permitted but certain waterborne activities may be regulated (USFWS, 2001, 2002a, 2002b).

Diving Behavior – Manatees are shallow divers. The distribution of preferred seagrasses is mostly limited to areas of high light; therefore, manatees are fairly restricted to shallower nearshore waters (Lefebvre et al., 2001). It is unlikely that manatees descend much deeper than 20 m (66 ft), and don't usually remain submerged for longer than 2 to 3 minutes. However, when bottom resting, manatees have been known to stay submerged for up to 24 minutes (Reynolds III, 1981).

Acoustics and Hearing **–** West Indian manatees produce a variety of squeak-like sounds that have a typical frequency range of 0.6 to 12 kHz (dominant frequency range from 2 to 5 kHz), and last 0.25 to 0.5 s (Steel and Morris, 1982; Thomson and Richardson, 1995; Niezrecki et al., 2003). Recently, vocalizations below 0.1 kHz have also been recorded (Frisch and Frisch, 2003; Frisch, 2006). Overall, West Indian manatee vocalizations are considered relatively stereotypic, with little variation between isolated populations examined (i.e., Florida and Belize; Nowacek et al., 2003). However, vocalizations have been newly shown to possess nonlinear dynamic characteristics (e.g., subharmonics or abrupt, unpredictable transitions between frequencies), which could aid in individual recognition and mother-calf communication (Mann et al., 2006). Average source levels for vocalizations have been calculated to range from 90 to 138 dB re: 1 μPa (average: 100 to 112 dB re 1 μPa) (Nowacek et al., 2003; Phillips et al., 2004). Behavioral data on two animals indicate an underwater hearing range of approximately 0.4 to 46 kHz, with best sensitivity between 16 and 18 kHz (Gerstein et al., 1999), while earlier electrophysiological studies indicated best sensitivity from 1 to 1.5 kHz (Bullock et al., 1982).

Distribution **–** West Indian manatees occur in warm, subtropical, and tropical waters of the western North Atlantic Ocean, from the southeastern United States to Central America, northern South America, and the West Indies (Lefebvre et al., 2001). West Indian manatees occur along both the Atlantic and Gulf coasts of Florida. West Indian manatees are sometimes reported in the Florida Keys; these sightings are typically in the upper Florida Keys, with some reports as far south as Key West (Moore, 1951a, 1951b; Beck, 2006a). During winter months, the West Indian manatee population confines itself to inshore and inner shelf waters of the southern half of peninsular Florida and to springs and warm water outfalls (e.g., power plant cooling water outfalls). As water temperatures rise in spring, West Indian manatees disperse from winter aggregation areas. West Indian manatees are frequently reported in coastal rivers of Georgia and South Carolina during warmer months (Lefebvre et al., 2001).

Historically, West Indian manatees were likely restricted to southernmost Florida during winter and expanded their distribution northward during summer. However, industrial development has made warm-water refuges available (e.g., power plant effluent plumes), and the introduction of several exotic aquatic plant species has expanded the available food supply. These factors have enabled an expansion of manatee winter range (USFWS, 2001; Laist and Reynolds, 2005).

Several patterns of seasonal movement are known along the Atlantic coast ranging from year-round residence to long-distance migration (Deutsch et al., 2003). Individuals may be highly consistent in seasonal movement patterns and show strong fidelity to warm and winter ranges, both within and across years (Deutsch et al., 2003).

Although West Indian manatees are expected to inhabit nearshore areas, a few individuals have been sighted offshore. A manatee hit by a boat in Louisiana was determined to be an individual previously photographed in the Tampa Bay, Florida area (Fertl et al., 2005). A West Indian manatee photographed in January 2000 in the Bahamas was matched to a manatee sighted as a juvenile in 1994 on the west coast of Florida, indicating the potential for offshore movements (Reid, 2000). Reynolds and Ferguson (1984) reported sightings of two manatees 61 km (33 NM) northeast of the Dry Tortugas Islands, an area not considered to be part of this species' range. "Mo," a radio-tagged manatee that had been raised in captivity and released at Crystal River, Florida, wandered offshore and then apparently drifted south with offshore currents and was "rescued" in deep water 37 km (20 NM) northwest of the Dry Tortugas (Lefebvre et al., 2001). Another manatee was also repeatedly sighted in the northern GOMEX, well over 100 km offshore in waters with a bottom depth of about 1,524 m (5,000 ft) (Fertl et al., 2005).

West Indian manatees off the east coast of Florida are also known to occasionally make their way further offshore. For example, "Xoshi" was radio-tagged and released in Biscayne Beach in March 1999. A few weeks later, she was "rescued" 60 km (32 NM) offshore of Port Canaveral, Florida in the Gulf Stream (Reid et al., 1991). Perhaps the most famous long-distance movements of any West Indian manatee were exhibited by the animal known as "Chessie," who gained fame in the summer of 1995 by swimming to Rhode Island, returning to Florida for the winter, and traveling north again to Virginia where he was last seen in 1996 (USGS, 2001). In early September 2001, "Chessie" was once again sighted in Virginia (USGS, 2001). More recently, in August 2006, a West Indian manatee was sighted in waters off Rhode Island, Massachusetts, and in the Hudson River in New York City (Anonymous, 2006; Beck, 2006b).

Atlantic Ocean, Offshore of the Southeastern United States

The endangered West Indian manatee occurs in nearshore waters, shoreward of the JAX/CHASN OPAREA with some individuals making their way further north along the East Coast towards the VACAPES OPAREA. However, there are no records for manatees in the VACAPES OPAREA. Manatees are not likely to occur in the vicinity of the VACAPES OPAREA.

There are no records for manatees within the CHPT OPAREA. Manatees have been sighted in estuarine and coastal waters of North Carolina in all seasons, with the greatest number of reports occurring during summer and fall. Manatees are not likely to occur in the CHPT OPAREA.

Although manatees potentially occur, it is unlikely that they would be seen in the Southeast OPAREAs. The manatee occurs primarily in freshwater systems, estuaries, and shallow nearshore coastal waters.

Atlantic Ocean, Offshore of the Northeastern United States

The West Indian manatee is extralimital to the northeast at all times of the year. Sightings on the Atlantic coast drop off markedly north of South Carolina (Lefebvre et al., 2001). In 1995, "Chessie" made a 4,828 km (2,605 NM), round-trip journey between Florida and Rhode Island, leaving Rhode Island in mid-August (USGS, 2001).

GOMEX

West Indian manatees occur year-round in coastal waters from Pensacola, Florida, south to the tip of Florida, although some sporadic occurrences have been documented as far west as Texas. This species is not likely to occur as far offshore as the OPAREA boundaries (6 km [3 NM]).

There are sightings in waters within the OPAREA boundaries, although manatee experts note that these should be considered anomalies due to the known habitat preferences of this species (Beck, 2006a).

3.6.2 Threatened and Endangered Marine Mammals

The ESA, as amended (16 United States Code [U.S.C.] Sections 1531 to 1544 [16 U.S.C. 1531 to 1544]), provides for the conservation of endangered and threatened species and their habitat. Volume 50 of the CFR contains the implementing regulations for the ESA. An endangered species is defined as one that is in danger of extinction throughout all or a significant portion of its range. A threatened species is one that is likely to become endangered in the foreseeable future throughout all or a significant portion of its range. The USFWS and/or NMFS publish a list of endangered or threatened species in the *Federal Register*.

The ESA prohibits the taking of any listed species, where "take" includes harassment, harm, pursuit, hunting, shooting, wounding, killing, trapping, capture, collection, or any attempts at these activities. Section 7(a)(2) of the ESA requires federal agencies to ensure that their actions do not jeopardize the continued existence of any listed endangered or threatened species. Section 7(a)(2) also requires that federal actions do not result in the destruction or adverse modification of designated critical habitat.

Of the marine mammals that may occur along the East Coast and GOMEX, six species of cetaceans, including five mysticete whales and one odontocete whale, and one sirenian species are currently listed as federally endangered. These species are:

- North Atlantic right whale
- Humpback whale
- Sei whale
- Fin whale
- Blue whale
- Sperm whale
- West Indian manatee

The ESA requires federal agencies to ensure that actions they undertake, authorize, or fund are not likely to jeopardize the continued existence of a listed species or result in the destruction or adverse modification of designated critical habitat. Under the ESA, the USFWS and/or NMFS designates critical habitat for each listed species. Critical habitat is defined as specific areas within or outside of the geographical area occupied by a listed species that contain physical or biological features essential to the species' conservation and that may require special management considerations or protection. Such features include food, water, shelter, breeding areas, and space for growth, among other requirements.

The endangered North Atlantic right whale is considered the rarest of all the large whale species in the AFAST Study Area. Most individuals in the North Atlantic migrate from wintering/calving areas in coastal waters off the southeastern United States to northern feeding/nursery grounds from New England to the Scotian Shelf. Critical habitat for the population of the North Atlantic right whale, exists in portions of the Boston (Northeast) and JAX OPAREAs, as shown in Figures 3-4 and 3-5, and discussed previously. The Navy will conduct all AFAST active sonar activities in the JAX OPAREA in a manner consistent with the 1997 Biological Opinion (NMFS, 1997). Hence, there would be no adverse modification to the North Atlantic right whale critical habitat in the JAX OPAREA since no significant changes to habitat or prey distribution would occur.

3.6.3 Cetacean Stranding Events

When a live or dead marine mammal swims or floats onto shore and becomes “beached” or incapable of returning to sea, the event is termed a “stranding” (Perrin and Geraci, 2002; Geraci and Lounsbury, 2005; NMFS, 2007j). The legal definition for a stranding within the United States is that “(A) a marine mammal is dead and is (i) on a beach or shore of the United States; or (ii) in waters under the jurisdiction of the United States (including any navigable waters); or (B) a marine mammal is alive and is (i) on a beach or shore of the United States and is unable to return to the water; (ii) on a beach or shore of the United States and, although able to return to the water, is in need of apparent medical attention; or (iii) in the waters under the jurisdiction of the United States (including any navigable waters), but is unable to return to its natural habitat under its own power or without assistance” (16 U.S.C. 1421h).

The majority of cetaceans that strand are dead or moribund (i.e., dying) (NMFS, 2007j). For animals that strand alive, human intervention through medical aid and/or guidance seaward may be required for the animal to return to the sea. If unable to return to sea, rehabilitation at an appropriate facility may be determined as the best opportunity for animal survival.

Three general categories can be used to describe strandings: single strandings, mass strandings, and unusual mortality events. The most frequent type of stranding is a single stranding, which involves only one animal (or a mother/calf pair) (NMFS, 2007j).

Mass stranding involves two or more marine mammals of the same species other than a mother/calf pair (Wilkinson, 1991), and may span one or more days and range over several miles (Simmonds and Lopez-Jurado, 1991; Frantzis, 1998; Walsh et al., 2001; Freitas, 2004). In North America, only a few species typically strand in large groups of 15 or more; these species include sperm whales, pilot whales, false killer whales, Atlantic white-sided dolphins, white-beaked dolphins, and rough-toothed dolphins (Odell 1987; Walsh et al. 2001). Some species, such as pilot whales, false-killer whales, and melon-headed whales occasionally strand in groups of 50 to 150 or more (Geraci et al. 1999). All of these normally pelagic offshore species are highly sociable and usually infrequently encountered in coastal waters. Species that commonly strand in smaller numbers include pygmy killer whales, common dolphins, bottlenose dolphins, Pacific white-sided dolphins, Frasier’s dolphins, gray whales, humpback whales, harbor porpoises, Cuvier’s beaked whales, California sea lions, and harbor seals (Mazzuca et al. 1999, Norman et al. 2004, Geraci and Lounsbury 2005).

UMEs can be a series of single strandings or mass strandings, or unexpected mortalities (i.e., die-offs) that occur under unusual circumstances (Dierauf and Gulland, 2001; Harwood, 2001; Gulland, 2006; NMFS, 2007j). These events may be interrelated: for instance, at-sea die-offs lead to increased stranding frequency over a short period of time, generally within one to two months. As published by NMFS, revised criteria for defining a UME include the following (Hohn et al., 2006):

1. A marked increase in the magnitude or a marked change in the nature of morbidity, mortality, or strandings when compared with prior records.
2. A temporal change in morbidity, mortality, or strandings is occurring.
3. A spatial change in morbidity, mortality, or strandings is occurring.
4. The species, age, or sex composition of the affected animals is different than that of animals that are normally affected.
5. Affected animals exhibit similar or unusual pathologic findings, behavior patterns, clinical signs, or general physical condition (e.g., blubber thickness).
6. Potentially significant morbidity, mortality, or stranding is observed in species, stocks or populations that are particularly vulnerable (e.g., listed as depleted, threatened or endangered or declining). For example, stranding of three or four right whales may be cause for great concern whereas stranding of a similar number of fin whales may not.
7. Morbidity is observed concurrent with or as part of an unexplained continual decline of a marine mammal population, stock, or species.

UMEs are usually unexpected, infrequent, and may involve a significant number of marine mammal mortalities. As discussed below, unusual environmental conditions are probably responsible for most UMEs and marine mammal die-offs (Vidal and Gallo-Reynoso, 1996; Geraci et al., 1999; Walsh et al., 2001; Gulland and Hall, 2005).

Reports of marine mammal strandings can be traced back to ancient Greece (Walsh et al., 2001). Like any wildlife population, there are normal background mortality rates that influence marine mammal population dynamics, including starvation, predation, aging, reproductive success, and disease (Geraci et al., 1999; Carretta et al., 2007). Strandings in and of themselves may be reflective of this natural cycle or, more recently, may be the result of anthropogenic sources (i.e., human effects). Current science suggests that multiple factors, both natural and man-made, may be acting alone or in combination to cause a marine mammal to strand (Geraci et al., 1999; Culik, 2002; Perrin and Geraci, 2002; Geraci and Lounsbury, 2005; NRC, 2006). While post-stranding data collection and necropsies of dead animals are attempted in an effort to find a possible cause for the stranding, it is often difficult to pinpoint exactly one factor that can be blamed for any given stranding. An animal suffering from one ailment becomes susceptible to various other influences because of its weakened condition, making it difficult to determine a primary cause. In many stranding cases, scientists never learn the exact reason for the stranding. Specific potential stranding causes can include both natural and human influenced (anthropogenic) causes as listed below:

- Natural Stranding Causes
  - Disease
  - Natural toxins
  - Weather and climatic influences
  - Navigation errors
  - Social cohesion
  - Predation
- Human Influenced (Anthropogenic) Stranding Causes
  - Fisheries interaction
  - Vessel strike
  - Pollution and ingestion
  - Noise

Specific beaked whale stranding events associated with naval operations are as follows:

- May 1996: Greece (NATO/US)
- March 2000: Bahamas (US)
- May 2000: Portugal, Madeira Islands (NATO/US)
- September 2002: Canary Islands (NATO/US)
- January 2006: Spain, Mediterranean Sea coast (NATO/US)

These events represent a small number of animals (40 animals) over an 11-year period and not all worldwide beaked whale strandings can be linked to naval activity (ICES, 2005a; 2005b; Podesta et al., 2006). Four (Greece, Portugal, Spain, Canary Islands) of the five events occurred during NATO exercises or events where DON presence was limited. One (Bahamas) of the five events involved only DON ships. These five events are described briefly below. For detailed information on these events, refer to Appendix E, Cetacean Stranding Report.

- May 1996, Greece - Twelve Cuvier's beaked whales (*Ziphius cavirostris*) stranded along the coast of the Kyparissiakos Gulf on May 12 and 13, 1996 (Frantzis, 1998). From May 11 through May 15, the NATO research vessel Alliance was conducting sonar tests with signals of 600 Hz and 3 kHz and root-mean-squared (rms) sound pressure levels (SPL) of 228 and 226 dB re: 1μPa, respectively (D'Amico and Verboom, 1998; D'Spain et al., 2006). The timing and the location of the testing encompassed the time and location of the whale strandings (Frantzis, 1998). However, because information for the necropsies was incomplete and inconclusive, the cause of the stranding cannot be precisely determined.
- March 2000, Bahamas – Seventeen marine mammals – including nine Cuvier's beaked whales, three Blainville's beaked whales (*Mesoplodon densirostris*), two unidentified beaked whales, two minke whales (*Balaenoptera acutorostrata*), and one spotted dolphin

(*Stenella frontalis*) – stranded along the Northeast and Northwest Providence Channels of the Bahamas Islands on March 15 – 16, 2000 (Evans and England, 2001). The strandings occurred over a 36-hour period and coincided with DON use of mid-frequency active sonar within the channel. Navy ships were involved in tactical sonar exercises for approximately 16 hours on March 15. The ships, which operated the AN/SQS-53C and AN/SQS-56, moved through the channel while emitting sonar pings approximately every 24 seconds. The timing of pings was staggered between ships and average source levels of pings varied from a nominal 235 dB SPL (AN/SQS-53C) to 223 dB SPL (AN/SQS-56). The center frequency of pings was 3.3 kHz and 6.8 to 8.2 kHz, respectively. Passive acoustic monitoring records demonstrated that no large scale acoustic activity besides the Navy sonar exercise occurred in the times surrounding the stranding event. The mechanism by which sonar could have caused the observed traumas or caused the animals to strand was undetermined.

- May 2000, Madeira Island, Portugal – Three Cuvier's beaked whales stranded on two islands in the Madeira Archipelago, Portugal, from May 10 – 14, 2000 (Cox et al., 2006). A joint NATO amphibious training exercise, named "Linked Seas 2000," which involved participants from 17 countries, took place in Portugal during May 2 – 15, 2000. The timing and location of the exercises overlapped with that of the stranding incident. Although the details about whether or how sonar was used during "Linked Seas 2000" are unknown, the presence of naval activity within the region at the time of the strandings suggested a Link.
- September 2002, Canary Islands – On September 24, 2002, 14 beaked whales stranded on Fuerteventura and Lanzarote Islands in the Canary Islands (Jepson et al., 2003). At the time of the strandings, an international naval exercise called "Neo-Tapon, 2002," that involved numerous surface warships and several submarines was being conducted off the coast of the Canary Islands. Tactical mid-frequency active sonar was utilized during the exercises, and strandings began within hours of the onset of the use of mid-frequency sonar (Fernández et al., 2005). The association of NATO mid-frequency sonar use close in space and time to the beaked whale strandings, and the similarity between this stranding event and previous beaked whale mass strandings coincident with sonar use, suggests that a similar scenario and causative mechanism of stranding may be shared between the events.
- January 2006, Spain – The Spanish Cetacean Society reported an atypical mass stranding of four beaked whales that occurred January 26 – 28, 2006, on the southeast coast of Spain near Mojacar (Gulf of Vera) in the Western Mediterranean Sea. From January 25-26, 2006, a NATO surface ship group (seven ships including one U.S. ship under NATO operational command) conducted active sonar training against a Spanish submarine within 92.7 km (50 NM) of the stranding site. According to the pathologists, a likely cause of this type of beaked whale mass stranding event may have been anthropogenic acoustic activities. However, no detailed pathological results confirming this supposition have been published to date, and no positive acoustic link was established as a direct cause of the stranding.

By comparison, potential effects to all species of cetaceans worldwide from fishery-related mortality can be orders of magnitude more significant (100,000s of animals versus 10s of animals) (Culik, 2002; ICES, 2005b; Read et al., 2006). This does not negate the influence of any mortality or additional stressor to small, regionalized sub-populations which may be at greater risk from human related mortalities (fishing, vessel strike, sound) than populations with larger oceanic level distribution or migrations. ICES (2005a) noted, however, that taken in context of marine mammal populations in general, sonar is not a major threat, or significant portion of the overall ocean noise budget. A constructive framework and continued research based on sound scientific principles are needed in order to avoid speculation as to stranding causes, and to further the understanding of potential effects or lack of effects from military mid-frequency sonar (ICES 2005b; Bradshaw et al., 2006; Barlow and Gisiner, 2006; Cox et al. 2006).

Refer to Appendix E, Cetacean Stranding Report, for additional information on the history of stranding, a description of the above-listed stranding events, a review of the many different possible reasons for stranding, as well as the stranding investigation findings and conclusions.

3.7 SEA TURTLES

Table 3-6 shows that all six sea turtle species occurring along the East Coast and in the GOMEX are listed as threatened or endangered. Current information about sea turtles indicates that their distribution is both specific to the species and to their stage in the life cycle. Most sea turtles associate with specific habitats during the life-cycle stages of post-hatchling, juvenile and subadult, and adult (Carr, 1987; Bolten et al., 1998). Nesting females and hatchling sea turtles make use of nesting beaches. Post-hatchling sea turtles prefer oceanic waters where *Sargassum* rafts are located (Lerman, 1986). Generally, larger juveniles and some adults (hard-shelled sea turtles) tend to favor benthic habitats in shallow nearshore waters, while other adults (leatherback sea turtles) are associated with deeper pelagic waters. Water temperature, seasonal changes, and migration patterns are other factors that affect the distribution of sea turtles.

Table 3-6. Sea Turtles with Possible or Confirmed Occurrence along the East Coast of the U.S. and in the Gulf of Mexico

Common Name	Scientific Name	ESA Status	Location
Order Testudines (Turtles)			
Suborder Cryptodira (Hidden-necked turtles)			
Family Cheloniidae (Hard-shelled sea turtles)			
Green sea turtle	*Chelonia mydas*	Threatened[1]	East Coast and GOMEX
Hawksbill sea turtle	*Eretmochelys imbricata*	Endangered	East Coast and GOMEX
Loggerhead sea turtle	*Caretta caretta*	Threatened	East Coast and GOMEX
Kemp’s ridley sea turtle	*Lepidochelys kempii*	Endangered	East Coast and GOMEX
Olive ridley turtle	*Lepidochelys olivacea*	Threatened	GOMEX
Family Dermochelyidae (Leatherback sea turtle)			
Leatherback sea turtle	*Dermochelys coriacea*	Endangered	East Coast and GOMEX

1. As a species, the green sea turtle is listed as threatened. However, the Florida and Mexican Pacific coast nesting populations are listed as endangered. It should be noted that green sea turtles found in the East Coast OPAREAs and eastern GOMEX might not all be from the Florida population.
Sources: DON, 2005, 2007a, 2007b, 2007c, 2007d

Sea turtle distribution in temperate waters generally shifts seasonally based on changes in water temperature and prey availability (Musick and Limpus, 1997; Coles and Musick, 2000). During winter months, sea turtles generally follow warmer water temperatures and prey abundance to areas offshore in southern regions of the East Coast. During other times, sea turtles may also commonly occur in nearshore and inshore waters. Some species are known to range as far north as Nova Scotia and Iceland during warmer months.

Sea turtle hearing sensitivity, in air and underwater, is not well studied. Reception of sound is through bone conduction, with the skull and shell acting as receiving structures (Lenhardt et al., 1983). Sea turtles are low frequency specialists, typically hearing frequencies from 30 to 2,000 Hz with a range of maximum sensitivity between 100 to 800 Hz (Ridgway et al., 1969b; Lenhardt, 1994; Moein Bartol and Ketten, 2006). Green turtle hearing has been tested in an out of the water. Ridgeway et al (1969b) found that green turtles hear airborne sounds ranging from 60 to 1,000 Hz and are most sensitive to airborne sounds ranging from 300 to 400 Hz (Ridgway et al., 1969b). Moein Barton and Ketten (2006) found that juvenile and subadult green turtles detect sounds from 100 to 500 Hz underwater, with maximum sensitivity at 200 and 400 Hz. Juvenile Kemp's ridleys were found to detect underwater sounds from 100 to 500 Hz with a maximum sensitivity between 100 and 200 Hz. Both the green turtles and Kemp's ridleys in this study showed peak auditory brainstem recordings between 5 and 7.5 ms after presentation of the stimulus (Moein Barton and Ketten, 2006).

Moein Bartol et al., (1999) reported that juvenile loggerhead turtles hear airborne sounds between 250 (lowest frequency that could be tested due to equipment) and 1,000 Hz (most sensitive at 250 Hz) using the auditory brainstem response (ABR) technique, while Lenhardt (2002) found that adults can hear airborne sounds from 30 Hz to 1,000 Hz (most sensitive at 400 to 500 Hz) using startle response (i.e., contract neck or dive) and ABR techniques. Adult loggerheads have also been observed to initially respond (i.e., increase swimming speeds) and avoid air guns when received levels range from 151 to 175 dB re 1 μPa, but most eventually habituate to these sounds with the exception of one turtle in the study that did exhibit TTS for up to two weeks after exposure to these levels (Lenhardt, 2002). Juveniles also have been found to avoid low-frequency sound (less than 1,000 Hz) produced by airguns (O'Hara and Wilcox, 1990). In a separate study, green and loggerhead sea turtles exposed to seismic air guns began to noticeably increase their swimming speed, as well swimming direction, when received levels reached 155 dB re 1 $\mu Pa^2 s$ for green turtles and 166 dB re 1 $\mu Pa^2 s$ for loggerhead turtles (McCauley et al., 2000a). Although auditory data have never been collected for the leatherback turtle, there is an anecdotal observation of a leatherback turtle responding to the sound of a boat motor (ARPA, 1995). It is unclear what frequencies of the sound this species was detecting. In terms of sound production, nesting leatherback turtles have been recorded producing sounds (sighs or belch-like sounds) up to 1,200 Hz with most energy ranging from 300 to 500 Hz (Mrosovsky, 1972; Cook and Forrest, 2005).

3.7.1 Sea Turtles of the U.S. North Atlantic and Gulf of Mexico

All six sea turtle species with records of occurrence along the East Coast or in the GOMEX are listed as threatened or endangered under the ESA. The hawksbill, Kemp's ridley, and leatherback turtles are listed as endangered, while the loggerhead turtle is listed as threatened. As a species, green turtles are listed as threatened, although specific nesting populations within this species' range are listed as endangered. As a species, the olive ridley is listed as threatened. However, the Pacific nesting population in Mexico is listed as endangered.

3.7.1.1 Green Sea Turtle (*Chelonia mydas*)

Description – The green sea turtle is the largest hard-shelled sea turtle; adults commonly reach 1 m (39 inches [in]) in carapace length and 150 kg (331 lb) in weight (NMFS and USFWS, 1991a). As hatchlings, green turtles are approximately 50 millimeters (mm) (2 in) long and 25 grams (g) (0.9 ounces (oz) in weight at birth. Green sea turtles in the Atlantic exhibit a decreased body weight growth rate as the carapace grows; this contrasts with the growth rates of Pacific greens (Bjorndal et al., 2000b). Adult carapaces range in color from solid black to gray, yellow, green, and brown in muted to conspicuous patterns; the plastron is a much lighter yellow to white. Hatchlings are distinctively black on the dorsal surface and white on the ventral. Greens are distinguishable by displaying four costal lateral scutes on the carapace and a serrated jaw, likely adapted for grazing (Ernst et al., 1994).

Status **–** Green sea turtles are classified as threatened under the ESA, with the Florida and Mexican Pacific coast nesting populations listed as endangered (NMFS and USFWS, 1991a). From 2001 to 2005, an average 5,055 green turtles nested in Florida; this estimate suggests Florida to have the second largest green sea turtle nesting population in the wider Caribbean (Meylan et al., 2006). Juvenile green sea turtles are the second most abundant sea turtle species in North Carolina summer developmental habitats (Epperly et al., 1995b). There is no estimate of the total number of green turtles in the GOMEX (NMFS and USFWS, 1991b).

Habitat Preferences **–** Post-hatchling and early-juvenile green sea turtles reside in convergence zones in the open ocean, where they spend an undetermined amount of time in the pelagic environment (Carr, 1987). The distinct coloration patterns of hatchlings and early-juvenile greens, a darker dorsal surface and lighter ventral surface, are ideal for an oceanic lifestyle. In laboratory experiments, Mellgren et al. (1994) found that hatchling green sea turtles did not orient to or congregate in artificial weed beds or in real seaweeds. However, (Carr and Meylan, 1980) present direct evidence of hatchlings taking refuge in and around *Sargassum* rafts. Mellgren et al. (1994) found green sea turtle post-hatchlings to spend a greater amount of time in the open ocean than other species known to associate with *Sargassum*. The suggested green sea turtle-*Sargassum* association may be due to juveniles and *Sargassum* being passively brought together by convergence zones (Carr, 1995).

The oceanic transport of juvenile greens emerging from U.S. Atlantic beaches is similar to the model proposed for juvenile loggerheads; neonate greens leave nesting beaches on the eastern Florida coast to enter the Gulf Stream (Witham, 1980; Musick and Limpus, 1997). Juveniles are eventually transported to the North Atlantic Gyre, a system that carries them around the North Atlantic Basin during the “lost year” phase. Once in the North Equatorial Current, individuals likely reach a carapace length of 20 to 25 cm (7.9 to 9.8 in). At this time, they migrate to nearshore development habitats and feeding areas in Florida and the Caribbean, where they spend the majority of their lives as late juveniles and adults (NMFS and USFWS, 1991a; Bjorndal and Bolten, 1988; Musick and Limpus, 1997).

The optimal developmental habitats for late juveniles and foraging habitats for adults are warm, shallow waters (3 to 5 m [10 to 16 ft] in bottom depth) with abundant submerged aquatic vegetation and in close proximity to nearshore reefs or rocky areas (Ernst et al., 1994). Green sea turtles may forage in either deep waters or in shallow seagrass beds (Hirth, 1997); in Hawaii, green turtles forage in waters as deep as 20 to 50 m (66 to 164 ft) (Brill et al., 1995), Along the east coast of Florida, juvenile green turtles use high wave-energy nearshore reef environments as developmental habitats; these areas support an abundance of macro-algae and are less than 2 m in depth (Holloway-Adkins, 2006). Many individuals travel close to shore due to preferences for feeding in shallow waters with an abundance of submerged vegetation (Ernst et al., 1994). However, green sea turtles have been seen in the open ocean more than 1,600 km (863 NM) from land (Fritts et al., 1983). In the GOMEX region, the preferred habitats of green turtles are located primarily along the coasts of southwestern Florida and southern Texas (Renaud et al., 1995; Landry and Costa, 1999). Juvenile green turtles also utilize the inshore and nearshore waters of central Florida (e.g., Cedar Keys, Homosassa Springs, Crystal River, and Tampa Bay) throughout the year as developmental habitats (NMFS and USFWS, 1991b; Dodd, 1995).

Distribution **–** Green sea turtles are distributed worldwide in tropical and subtropical waters (NMFS and USFWS 1991a). In U.S. Atlantic waters, greens are found around the U.S. Virgin Islands, Puerto Rico, and the continental United States from Texas to Massachusetts (NMFS and USFWS, 1991a). Important feeding areas for green sea turtles in the continental United States include waters in Florida and southern Texas, such as the Indian River Lagoon, Florida Keys, Florida Bay, Homosassa Springs, Crystal River, Cedar Keys, and the Laguna Madre Complex (NMFS and USFWS, 1991a; Landry and Costa, 1999). Benthic-feeding juveniles may be found in developmental habitats spanning the U.S. Atlantic coast. As adults, green sea turtles are restricted to more southern latitudes (Epperly et al., 1995a), and are only occasionally found north of Florida. During non-breeding periods, adult and juvenile distributions may overlap in coastal feeding areas (Hirth, 1997).

As they grow, green turtles move through a series of developmental feeding habitats (Hirth, 1997). Along the U.S. Atlantic Coast, developmental habitats range from Long Island Sound south to the Caribbean (Musick and Limpus, 1997). Juvenile green turtles may primarily use Florida coastal waters as developmental habitat, but may also use estuarine waters along the U.S. Atlantic coast as summer developmental habitat, as far north as Long Island Sound, Chesapeake Bay, and Core Sound, and Pamlico Sound (Musick and Limpus, 1997). In Florida, smaller juvenile green turtles may use worm-rock reefs as demersal developmental habitat, feeding on various types of algae, sponges, and benthic invertebrates (Guseman and Ehrhart, 1990; Bresette et al., 1998; Makowski et al., 2006). Makowski et al. (2006) found juvenile green sea turtles off Palm Beach, Florida, to use the same worm-rock reefs for foraging and resting purposes.

Sea surface temperature is a major factor that often determines the distribution and abundance of green turtles along the U.S. Atlantic coast. Individuals occurring in temperate waters avoid becoming cold-stunned by either moving offshore or toward more southerly latitudes prior to the onset of winter. Cold-stunning usually happens when water temperatures drop to 10°C (50°F) or below and can result in death if the cold period is extended and/or the temperature drops below 6.5°C (43.7°F). Green turtles lose the ability to dive at 9°C (48.2°F) and remain floating horizontally until they either warm up or die (Schwartz, 1978). Most records of individuals found north of Florida are from the warmer part of the year, between late spring and early fall

(CETAP, 1982; Epperly et al., 1995b) and are late juveniles to subadults (Lazell, 1980; Burke et al., 1992; Epperly et al., 1995b). Small numbers of these age classes regularly occur as far north as Long Island, New York from June through October, when the waters are warm enough to support green turtles (Morreale et al., 1992). The highest proportions of green sea turtles in North Carolina waters are observed in the fall (Epperly et al., 1995b), in conjunction with the southward migration of juvenile greens moving to warmer waters for the winter, although cold-stunning may occur off northeastern Florida as well (Mendonça, 1983).

The major Atlantic nesting colonies are located at Ascension Island (in the South Atlantic Ocean, about mid-way between South America and Africa), Aves Island (in the Caribbean Sea, about 180 km (97 NM) west of Guadaloupe), and on the beaches of Costa Rica and Suriname (in central and South America, respectively) (NMFS and USFWS, 1991a). Most nesting in North America occurs in southern Florida and Mexico (Meylan et al., 1995), with scattered records in the Florida Panhandle, Alabama, Georgia, and the Carolinas (Peterson et al., 1985; Schwartz, 1989; NMFS and USFWS, 1991a; USAF, 1996). Florida represents the major nesting site in the continental United States (Meylan et al., 2006). Most nesting in the GOMEX region occurs along the southern Florida and Mexican beaches, with scattered records from the Florida Panhandle, Alabama, and Texas (NMFS and USFWS, 1991b; Meylan et al., 1995; USAF, 1996). The highest concentration of nesting activity occurs in Monroe County, Florida, which includes most of the Florida Keys and the Dry Tortugas (Meylan et al., 1995).

Adult green sea turtles are known to undertake long migrations, the longest of which are between their foraging habitats and nesting beaches. For example, green sea turtles nesting on Ascension Island in the South Atlantic Ocean travel more than 2,200 km (1,187 NM) to feeding grounds off coastal Brazil (Åkesson et al., 2003). Analyses on foraging populations of juveniles have revealed that developmental feeding habitats likely contain green turtles from multiple stocks. Green turtles occurring on foraging grounds off the U.S. Atlantic and Gulf coasts include animals hatched on nesting beaches in Costa Rica, the United States, Mexico, Aves Island, Suriname, Ascension Island, and Guinea Bissau (western Africa) (Lahanas et al., 1998). Off the central coast of Florida, in the area of Hutchinson Island, foraging green turtles originate from Costa Rica (53 percent), the United States and Mexico (42 percent), and Aves Island and Suriname (4 percent) nesting populations (Bass and Witzell, 2000).

Atlantic Ocean, Offshore of the Southeastern United States

Green turtles may occur throughout the VACAPES OPAREA from spring through fall, and are least common within the OPAREA during the winter. Summer represents the peak time for green turtle occurrence in the VACAPES OPAREA due to the presence of summer developmental foraging habitat along the coast.

Green sea turtles may occur within the CHPT OPAREA year-round. Juvenile greens use developmental habitats adjacent to the CHPT OPAREA during the summer months as well as travel to and from these habitats during the spring and fall. During spring, summer, and fall, high concentrations of greens occur offshore the more northern states, specifically North Carolina, Virginia, Delaware, and New Jersey. Year-round, green turtle occurrence records are clustered along the North Carolina coast and within shelf waters.

Green sea turtles may occur within the JAX/CHASN OPAREA year-round. Year-round resident juvenile green turtles along the Atlantic coast of Florida are found in the Indian River Lagoon as well as Florida Bay/Florida Keys south of the OPAREA (NMFS and USFWS, 1991b). During the summer months, juvenile green sea turtles use developmental habitats outside of the OPAREA and migrate through the JAX/CHASN OPAREA to reach these habitats in the spring and fall. During the winter, the highest concentration of greens occurs just north of Cape Canaveral, Florida, a known overwintering area for juveniles. Throughout the year, green turtle occurrences in the OPAREA are concentrated over the continental shelf to the west of the Gulf Stream Current.

Atlantic Ocean, Offshore of the Northeastern United States

Generally, green sea turtles can occur from spring to fall in nearshore waters of the Northeast OPAREAs as far north as Cape Cod Bay and in offshore waters as far north as the southern flank of Georges Bank (NMFS and USFWS, 1991b; Prescott, 2000). Small numbers of juveniles regularly occur as far north as Long Island Sound, where waters are warm enough to support them from June through October (Burke et al. 1992). In spring, green turtles may be found in the southern portion of the Northeast OPAREAs as they make their way towards inshore developmental habitats (e.g., Long Island Sound, Peconic Bay, and possibly Nantucket Sound) from waters further south. These inshore, estuarine habitats, which possess an abundance of algae and eelgrass, are more often utilized by green sea turtles during summer and early fall than ocean habitats of the Mid-Atlantic Bight (Lazell, 1980; Morreale and Standora, 1998). The abundance of green turtles in inshore waters adjacent to the Northeast OPAREAs likely peaks in September (Berry et al., 2000). In fall, green turtles will begin to emigrate from these inshore areas and will pass through the Narragansett Bay and Atlantic City OPAREAs on their way to overwintering habitats south of Cape Hatteras or associated with the Gulf Stream Current. Green turtles that do not vacate the area in late fall may become susceptible to cold-stunning, as evidenced by the large number of strandings that occur along the beaches of Long Island and Cape Cod. The absence of sighting records in the Northeast OPAREAs during fall demonstrates the difficulties inherent in observing young hard-shelled sea turtles during marine surveys, as green sea turtles are no doubt present in nearshore waters of the Mid-Atlantic at that time of year.

Gulf of Mexico

In the winter, outside of the Florida Keys, there are few sighting records available for green turtles. This lack of sightings may be attributable to the possible underwater hibernation of overwintering green turtles in the northern GOMEX (Ogren and McVea, 1982), or the difficulty in identifying green turtles to species during winter sighting surveys (as sighting conditions are typically the worst during this season). Across all seasons, the ability to detect animals is influenced by the survey platform (aerial detection being more effective than shipboard observation). Therefore, survey methods may impact sighting numbers. During winter, green turtles may occur in the Key West, Pensacola, and Panama City OPAREAs.

In spring as water temperatures rise from April to June, green turtles begin to appear in greater numbers in the continental shelf waters of the northern GOMEX. However, sighting records for the area remain infrequent and occurrences are only predicted for one area located beyond the continental shelf. Green sea turtles found in these deeper waters are likely adults that are migrating from resident foraging grounds to distant nesting grounds (Meylan, 1995). Stranding activity along Florida's Atlantic and Gulf coasts remains high in spring, indicating a likely presence of green sea turtles in waters either just offshore or further inshore. Although continental shelf waters off western Florida have been documented as preferred habitats of the species during much of the year (Fritts et al., 1983b; NMFS and USFWS, 1991b), the lack of survey effort in this area precludes a definitive determination of green turtle occurrence in those waters during spring. The sparse sighting records in Louisiana and Texas waters as well as nesting records on the southern Texas coast indicate that green turtles are found in the northwestern Gulf during spring, although not in nearly the numbers that occur in the northeastern Gulf.

In summer, the occurrence pattern of green turtles in the GOMEX during summer is similar to that of spring, i.e., throughout the waters of the northern GOMEX continental shelf, although green turtles occur in greater numbers during summer. Sightings in the area are sporadic and were recorded in shelf waters during summer although survey effort extended beyond the continental shelf in several areas of the northern GOMEX. The post-nesting route of green turtle "Halie" shows that adult green turtles may traverse the GOMEX waters during their late summer migrations back to resident feeding areas. Reasons for the lack of green sea turtle occurrences could include difficulties inherent in identifying turtles during sighting surveys and their tendency to reside in inshore or very nearshore waters during summer months.

In fall, the highest concentrations of green sea turtles may occur in continental shelf waters from Charlotte Harbor south to the Florida Keys (Key West OPAREA). Multiple sightings were recorded in these waters during NMFS-SEFSC aerial surveys of the eastern GOMEX and only few sighting observations were recorded elsewhere in the area. In addition, Kinzel et al. (2003) have documented a high and continuous utilization of southwestern Florida waters by post-nesting female green turtles in late fall, winter, and early spring. Other areas of likely fall occurrence include the Cedar Keys region off central Florida, continental shelf waters off Galveston Bay, and waters associated with the continental shelf break northeast of the Corpus Christi OPAREA. Nesting also has been recorded during fall in one Panhandle Florida county, so it is likely that green turtles also occur at least sporadically in this region during fall.

3.7.1.2 Hawksbill Sea Turtle (*Eretmochelys imbricata*)

Description **–** The hawksbill turtle is a small to medium-sized sea turtle; adults typically range between 65 and 90 cm (26 to 35 in) in carapace length and weigh around 80 kg (176 lb) (Witzell, 1983; NMFS and USFWS, 1993). Hawksbills are distinguished from other sea turtles by their hawk-like beaks, posteriorly overlapping carapace scutes, and two pairs of claws on their flippers (NMFS and USFWS, 1993). The carapace of this species is often brown or amber with irregularly radiating streaks of yellow, orange, black, and reddish-brown.

Status **–** Hawksbill turtles are listed as endangered under the ESA and are second to the Kemp's ridleys in terms of endangerment (NMFS and USFWS, 1993; Bass, 1994). The most recent estimate of hawksbill abundance in the wider Caribbean was 4,975 nesting females calculated by Meylan in 1989 (Meylan and Donnelly, 1999). An estimated 1,900 to 4,300 adult females comprise the Mexican Atlantic nesting population (Garduño-Andrade et al., 1999). Only five regional populations worldwide remain with more than 1,000 females nesting annually (Seychelles, Mexico, Indonesia, and two in Australia) (Meylan and Donnelly, 1999). Very little is known about the status or abundance of this species along the U.S. Atlantic Coast aside from the recognition that hawksbill populations in this area are neither declining nor showing indications of recovery (Dodd, 1995; Plotkin, 1995). Little is known about the status of this species in the GOMEX (Dodd, 1995). In the Caribbean, there is designated critical habitat for hawksbills at Mona and Monito islands, Puerto Rico (NMFS, 1998c).

Habitat Preferences **–** Hawksbill post-hatchlings and early juveniles inhabit oceanic waters where they are sometimes associated with floating patches of *Sargassum* (NMFS and USFWS, 1993; Parker, 1995). Hawksbills recruit to benthic foraging grounds when they are 20 to 25 cm (7.9 to 9.8 in) in length (NMFS, 1993). The developmental habitats for juvenile benthic-stage hawksbills are the same as the primary feeding grounds for adults; these include tropical, nearshore waters associated with coral reefs or mangroves (Musick and Limpus, 1997). Shallow seagrass beds may also serve as important developmental habitats for late juvenile hawksbills (Bjorndal and Bolten, 1988; Diez et al., 2003). Several sporadic reports exist of hawksbills residing in seagrass habitats; for example, there is a development habitat for juvenile hawksbills at Saona Island, Dominican Republic (Diez et al., 2003).

Coral reefs are recognized as optimal hawksbill habitat for juveniles, sub-adults, and adults. Preference for these habitats is likely related to the presence of sponges, a favored prey item of hawksbills that comprises as much as 95 percent of their diet in some locations (NMFS and USFWS, 1993; Diez et al., 2003). Ledges, caves, and root systems, which are often interspersed among these habitats, provide hawksbills refuge and shelter (NMFS and USFWS, 1993). Sparse hard-bottom communities and cliff-wall habitats with soft corals and invertebrates are also considered important hawksbill benthic developmental habitat (Diez et al., 2003).

Hawksbills prefer alternate sites for resting and foraging. Resting sites tend to be deeper than foraging areas, although bottom topography influences site selection as well (Houghton et al., 2003). In neritic habitats, resting areas for late juvenile and adult hawksbills are typically located in deeper waters, such as sandy bottoms at the base of a reef flat, than their foraging areas (Houghton et al., 2003). Late juveniles generally reside on shallow reefs less than 18 m deep. However, as they mature into adults, hawksbills move to deeper habitats and may forage to depths greater than 90 m (295 ft). Benthic-stage hawksbills are seldom found in waters beyond the continental or insular shelf, unless they are in transit between distant foraging or nesting grounds (NMFS and USFWS, 1993).

Hawksbill turtles prefer to nest on the same tropical high-energy beaches as green turtles. Although hawksbills exhibit a wide tolerance for nesting substrate type, they prefer undisturbed, deep-sand beaches underneath vegetative cover (NMFS and USFWS, 1993; Comer, 2002). The hawksbill's small size and agility allows it to access nesting sites atop narrow and steeply sloped beaches as well as across fringing reefs, areas that are rarely accessible to other sea turtle species (NMFS and USFWS, 1993; Comer, 2002).

Distribution **–** Hawksbill turtles are circum-tropical in distribution, generally occurring from 30°N to 30°S within the Atlantic, Pacific, and Indian oceans (Witzell, 1983). In the western North Atlantic Ocean, this species is found throughout the GOMEX, the Greater and Lesser Antilles, southern Florida, and along the mainland of Central America south to Brazil (NMFS and USFWS, 1993). Juvenile and adult hawksbills are regularly found in the GOMEX, the Caribbean Sea, and along the Atlantic coast of southern Florida (Witzell, 1983; NMFS and

USFWS, 1993). Major foraging populations in U.S. waters occur in the vicinity of the coral reefs surrounding Mona Island, Puerto Rico and Buck Island, St. Croix, U.S. Virgin Islands (Van Dam and Diez, 1996; Starbird et al., 1999). Smaller populations of hawksbills reside in the hard bottom habitats that surround the Florida Keys and other small islands in Puerto Rico and the U.S. Virgin Islands (Witzell, 1983; NMFS and USFWS, 1993).

The hawksbill is rare north of Florida (Plotkin 1995). Morreale et al (1989) recorded a hawksbill specimen in the Long Island Sound, and (Parker, 1995) documented several sightings of juveniles and “lost year” hatchlings off the coasts of Massachusetts, Virginia, North Carolina, and Georgia. There are four other published records of hawksbills in North Carolina waters, including one 32 km (17 NM) east of Oregon Inlet (Lee and Palmer, 1981). Unpublished reports include a young hawksbill stranding cold-stunned on the Outer Banks of North Carolina in 2001 (Lee and Palmer, 1981; Mazzarella, 2001; Godfrey, 2003)) and a yearling hawksbill stranding near the North Carolina/Virginia border in 2003 (Godfrey, 2003). In 1990, a hawksbill was captured in Virginia at the mouth of the James River (Keinath et al., 1991), and in 2000, another individual stranded live at Virginia Beach (USFWS, 2001).

Hawksbills were originally thought to be a non-migratory species due to the close proximity of suitable nesting beaches to coral reef feeding habitats and high rates of local recaptures. However, individuals are now known to travel long distances over the course of their lives (Meylan, 1999), mainly between nesting and foraging areas. Transoceanic migrations are known from both tagging and genetic analyses (Bellini et al., 2000; Bowen et al., 2007). For example, a subadult tagged in Sueste Bay at Fernando de Noronha Archipelago, Brazil and captured at Cap Esterias, Gabon represents the longest documented movements for this species – a straight-line distance of 4,669 km (2,519 NM) (Bellini et al., 2000). The 1,600 km (863 NM) journey of a post-nesting female traveling between Santa Isabel Island, Soloman Islands and Port Moresby, Papua New Guinea is also noteworthy (Meylan, 1995).

Tag return, genetic, and telemetry studies have indicated that Caribbean hawksbill turtles use multiple developmental habitats as they progress from one age class to another. Within a given life stage, such as the later juvenile stage, some hawksbills may choose to be sedentary within a specific developmental habitat for a long period of time (Meylan, 1999). For example, in February 1985, a benthic-stage juvenile was captured from the coastal waters surrounding an islet in the southern Ryukyu Islands. A year and a half later, the same individual was recaptured in a lagoon only 9 km (5 NM) away from its original capture site (Kamezaki, 1987).

The largest nesting aggregation in the Caribbean occurs along the Yucatán Peninsula, Mexico (NMFS and USFWS, 1993). Other small, yet important, nesting assemblages are found in Belize, Nicaragua, Panama, Venezuela, Cuba, Antigua, and the Grenadines (NMFS and USFWS, 1993). Within the continental United States, hawksbill nesting is restricted to beaches in southern Florida and the Florida Keys, although even there it is extremely rare (Dodd, 1995). Nesting has been documented at Jupiter Island, Biscayne National Monument, and the Canaveral National Seashore on the eastern Florida coast (Lund, 1985).

Atlantic Ocean, Offshore of the Southeastern United States

Hawksbills are rare within the VACAPES OPAREA, yet may occur throughout the year. Based upon limited data, occurrences are likely to be more common within shelf waters or along the shelf break). As this species is typically tropical, any occurrences within the VACAPES OPAREA are likely accidental. Many hawksbill strandings adjacent to the OPAREA have been small juveniles (Frick, 2001; Mazarella, 2001; Godfrey, 2003) suggesting individuals may enter the OPAREA from pelagic juvenile habitat. Sightings and bycatch records along the shelf break may support this. However, VACAPES OPAREA waters do not offer optimal developmental habitat for juvenile or foraging habitat for adults (NMFS and USFWS, 1993; Diez et al., 2003), and individuals would not be likely to remain in the OPAREA.

Although rare, hawksbills may occur within the CHPT OPAREA at any time during the year. Based upon sighting and stranding records, occurrences are generally likely to be inshore and within shelf waters. As this species is typically tropical, any occurrences within the CHPT OPAREA are likely accidental. Many hawksbill strandings in North Carolina have been small juveniles (Frick, 2001; Mazarella, 2001; Godfrey, 2003) suggesting individuals may enter the CHPT OPAREA from pelagic juvenile habitat. Yet as North Carolina waters do not offer optimal developmental habitat for juvenile or foraging habitat for adults adults (NMFS and USFWS, 1993; Diez et al., 2003), individuals would not be likely to remain in the OPAREA.

Although rare, hawksbills may occur within the JAX/CHASN OPAREA at any time during the year. Based on sighting, stranding, and bycatch data, hawksbills may occur throughout the OPAREA. The majority of animals stranded or sighted in or near the JAX/CHASN OPAREA are immature (Meylan, 1992; Parker, 1995). The hawksbill is a tropical species and is more likely to be found along the southern portion of Florida (NMFS and USFWS, 2007) (Meylan and Redlow 2006); however a recent hypothesis suggests that the Florida Current and the Gulf Stream may represent a dispersal corridor for Caribbean and Gulf region post-hatchlings (Meylan and Redlow, 2006).

Atlantic Ocean, Offshore of the Northeastern United States

This species likely does not occur in the northeast with any regularity, although infrequent sightings and strandings have been recorded during three of the four seasons. Currently, Massachusetts is recognized as the northern limit of the species' range (NMFS and USFWS, 1993). However, most scientists believe that any sightings in this region of the western North Atlantic Ocean should be considered rare or even accidental (Lazell, 1980; Prescott, 2000). In addition, coral reefs and live/hard bottom habitats, which are the preferred habitats of hawksbills, are not very prevalent in the northeast. If a hawksbill were to occur in the waters of the Northeast OPAREAs, it would likely be during summer when water temperatures peak. It is possible that there are more hawksbills in the area during summer months than the survey data imply, as individuals of this species are likely below the size threshold for effective detection by aerial observers (Thompson, 1991).

Gulf of Mexico

Like the green turtle, the hawksbill primarily inhabits shallow, nearshore waters off southern Florida. Small numbers of hawksbill occurrences are documented from winter to summer from southeastern Florida (Palm Beach, Broward, and Dade Counties) through the Florida Keys to coastal waters just northwest of Tampa Bay, where the northernmost stranding records occur, but the greatest number of hawksbill turtles is found off southern Florida in fall. The prevalence of coral reef and hard-bottom habitats off southern Florida should cause small populations of juveniles and adults to feed there throughout the year. Further north and west, hawksbills are rarely observed in waters off the Florida Panhandle, Alabama, Mississippi, Louisiana, and Texas (Rabalais and Rabalais, 1980; Witzell, 1983; Rester and Condrey, 1996). Hawksbill sightings in these areas likely involve early juveniles that are born on nesting beaches in Mexico and have drifted north with the dominant currents (Landry and Costa, 1999). Aside from documentations of early juveniles associated with *Sargassum* mats and long-distance tag returns from migrating adult females, scientists know relatively little about the offshore distribution of this species in the GOMEX.

The only available winter sighting records in the area are from the Florida Keys. All other hawksbill occurrence records for winter are strandings, which take place from southeastern Florida to just north of Tampa Bay. Sighting effort is non-existent in several areas off southern Florida where hawksbills are likely to be found throughout the year. Winter water temperatures in the northern GOMEX waters are likely outside the thermal tolerance of hawksbill turtles, which is a likely factor for the absence of occurrence records for the Florida Panhandle, Alabama, Mississippi, Louisiana, and eastern Texas. Winter strandings of hawksbills off central Florida are probably the result of low water temperatures in the area.

In spring, hawksbill turtles may expand their range into the northernmost waters of the GOMEX, as evidenced by the sighting record off Louisiana's Chandeleur Islands and in the deeper waters off the Florida shelf. These Florida waters lie a short distance west of Christmas Ridge (a known live/hard bottom community) and north of Pulley Ridge (a known coral reef community); it is unclear whether the hawksbills observed in Florida were in transit to or from potential feeding areas. Stranding records remain restricted to the central and southern Florida regions. Multiple strandings in the Florida Keys and along the southeast Florida coast indicate a likely greater presence of hawksbills in those southern Florida coastal areas compared to offshore waters beyond the west Florida shelf.

In summer, although there are fewer hawksbill occurrence records for the area compared to the other three seasons, hawksbills are still expected to occur at least rarely in the subtropical, nearshore waters off southern Florida. Low levels (less than three) of nesting activity are also known to take place on west Florida beaches during this season (Meylan et al., 1995). Hawksbill turtles should be more abundant in the area during summer compared to any other season due to the potential for nesting turtles (which may come from distant waters such as the Caribbean Sea) to inhabit the area with resident foraging populations.

Due to the rigorous NMFS-SEFSC aerial surveys over the eastern GOMEX in 1994, fall is by far the season with the most hawksbill sighting records, clustered off southern Florida. Based upon the concentration and clustering of available sightings off southwestern Florida, the sighting data indicates that hawksbills are regular inhabitants of waters surrounding the westernmost islands of the Florida Keys and may be found on the west Florida shelf as far north as Charlotte Harbor. Fall occurrences may also be possible in the northwestern GOMEX, as demonstrated by a hawksbill sighting in continental shelf waters south of the Texas/Louisiana border.

3.7.1.3 Loggerhead Sea Turtles (*Caretta caretta*)

Description **–** Loggerheads are large, hard-shelled sea turtles. The mean straight carapace length (SCL) of adult loggerheads in southeastern U.S. waters is approximately 92 cm (36 in) and the average weight is 113 kg (249 lb) (NMFS and USFWS, 1991b). The size of a loggerhead turtle's head compared to the rest of its body is substantially larger than that of other sea turtles. Adults are mainly reddish-brown in color on top and yellowish underneath.

Status **–** Loggerhead turtles are listed as threatened under the ESA. The loggerhead is the most abundant sea turtle occurring in U.S. waters. Annual nesting totals of loggerheads on the U.S. Atlantic and Gulf coasts ranged from 53,016 to 89,034 nests during 1989 to 1998 (TEWG, 2000). In the western North Atlantic Ocean, there are at least five demographically independent loggerhead nesting groups or subpopulations: (1) Northern: North Carolina, South Carolina, Georgia and northeast Florida; (2) South Florida: occurring from 29°N on the east coast to Sarasota on the west coast; (3) Florida Panhandle: Eglin Air Force Base and the beaches near Panama City, Florida; (4) Yucatán: the eastern shore of the Yucatán Peninsula, Mexico; and (5) Dry Tortugas: near Key West, Florida (Encalada et al., 1998; TEWG, 2000; Epperly et al., 2001). Small but significant nesting aggregations are also known from the Bahamas, Cuba, and Alabama (Dodd, 1988; Phillips, 2005). The South Florida nesting subpopulation is the largest known loggerhead nesting assemblage in the Atlantic Ocean (annual nesting totals ranged from 48,531 to 83,442 nests from to 1985 through 2000) and is the second largest in the world (TEWG, 2000). Nesting trends indicate that the number of nesting females associated with the South Florida Subpopulation is likely increasing (Epperly et al., 2001). The Florida Panhandle subpopulation appears to be the third largest in size of the U.S. nesting subpopulations with annual nesting numbers between 113 and 1,295 between 1989 and 2002 (NMFS and USFWS, 2003). However, both the Northern (North Carolina to northeast Florida) and Florida Panhandle nesting subpopulations are believed to be in decline as a result of decreasing numbers of nesting females over the past several years (NMFS, 2002b). In 1998, loggerhead nesting totals from North Carolina, South Carolina, Georgia, and northern Florida were approximately 7,500 nests (TEWG, 2000). From 1989 to 1998, the Northern nesting subpopulation accounted for 8.5 percent of nesting on the U.S. Atlantic and Gulf coasts (TEWG, 2000).

Habitat Preferences **–** The loggerhead turtle occurs worldwide in habitats ranging from coastal estuaries to waters far beyond the continental shelf (Dodd, 1988). Loggerhead migrations consist of travel to early juvenile nursery habitat, later juvenile developmental habitat, adult foraging habitat, and adult internesting or breeding habitat, and may be based upon the ontogeny of life stages (Musick and Limpus, 1997). Loggerheads are primarily oceanic as post-hatchlings and early juveniles. Post-hatchling loggerheads are transported throughout the ocean by dominant currents (Bolten and Balazs, 1995) and often use the currents of the North Atlantic Gyre System to aid in travel during developmental migrations (Bolten et al., 1998). *Sargassum* likely provides optimal foraging opportunities and habitat for loggerhead hatchlings, yet individuals may also be sighted at the surface off the Florida coast and unassociated with *Sargassum* drift lines (Smith, 1968).

Juveniles may also use small-scale surface currents for transportation, migrating counter to North Atlantic prevailing currents (Cejudo et al., 2006). Once departing western Atlantic nesting grounds, post-hatchlings travel to oceanic waters surrounding the Azores and Madeira, the Grand Banks (Newfoundland, Canada), and the Mediterranean Sea (Bowen et al., 2004). Genetic evidence demonstrates that pelagic loggerheads found near the Azores are often derived from the nesting populations in the southeastern U.S. (Bolten et al., 1994, Bolten et al., 1998). After reaching a certain size, early juvenile loggerheads will then make a trans-oceanic crossing back towards the western Atlantic Ocean (Musick and Limpus, 1997), actively swimming to neritic feeding grounds near their natal beach of origin (Bowen et al., 2004). Based on growth rate estimates, the duration of the pelagic juvenile stage for North Atlantic loggerheads is estimated to be approximately 8.2 years, with Pacific loggerheads recruiting to demersal habitats at a larger size (Bjorndal et al., 2000a).

Small benthic-feeding immatures are the predominant loggerhead size class found along the northeast and mid-Atlantic U.S. coast (TEWG, 1998); adults are known to use the entire continental shelf area (Hopkins-Murphy et al., 2003). Juveniles are frequently observed in developmental habitats; such habitats include coastal inlets, sounds, bays, estuaries, and lagoons of less than 100 m (328 ft) in depth (TEWG, 1998; Hopkins-Murphy et al., 2003). Juveniles recruit to these neritic feeding grounds at the size of approximately 40 cm (16 in) (Carr, 1987). Core Sound and Pamlico Sound, North Carolina represent important developmental habitat for juvenile loggerheads (Epperly et al., 1995b). Although these habitats are also used by other species, such as greens and Kemp's ridleys, loggerheads represent the most abundant sea turtle species within the North Carolina summer developmental habitats (Epperly et al., 1995b).

Based on growth models, immature loggerheads may occupy coastal feeding grounds for 20 years before their first reproductive migration (Bjorndal et al., 2001). Juvenile loggerheads are also known to inhabit offshore waters in the North Atlantic Ocean where they are often associated with natural and/or artificial reefs (Fritts et al., 1983). These offshore habitats provide juveniles with an abundance of prey as well as sheltered locations where they can rest (Rosman et al., 1987). As later juveniles and adults, loggerheads most often occur on the continental shelf and along the shelf break of the U.S. Atlantic and Gulf coasts as well as coastal estuaries and bays (CETAP, 1982; Shoop and Kenney, 1992). Sub-adult and adult loggerhead turtles tend to inhabit deeper offshore feeding areas along the western Atlantic coast, from mid-Florida to New Jersey (Hopkins-Murphy et al., 2003; Roberts et al., 2005). Hawkes et al. (2007) found adult females to forage predominantly in shallow coastal waters along the U.S. Atlantic coast less than 100 m (328 ft) deep, likely exploiting benthic prey. Turtles were found to use significantly shallower water and larger areas for foraging than for overwintering. In addition, turtles exhibited preference to these particular areas (Hawkes et al., 2007).

Loggerheads typically nest on high-energy beaches close to reef formations and adjacent to warm-temperature currents (Dodd, 1988). Nesting beaches facing the open ocean or situated along narrow bays are preferred (NMFS and USFWS, 1991b). Nest site selection tends to depend more upon beach slope and width than temperature, moisture, or salinity (Wood and Bjorndal, 2000). Adult loggerheads exhibit strong site fidelity to nesting beaches by consistently returning to their natal beaches to nest (Comer, 2002).

Distribution **–** Loggerhead turtles are found in subtropical and temperate waters throughout the world (NMFS and USFWS, 1991b). The loggerhead numbers in the thousands throughout inner continental shelf waters of the Atlantic coast from Cape Cod to southern Florida and the Gulf Coast from southern Florida to southern Texas.

Off the eastern United States, loggerheads are commonly sighted across the shelf from the shore to the shelf break as far north as Long Island, although far north and east sightings are sparse (CETAP, 1982); (Shoop and Kenney, 1992). North of Cape Hatteras, North Carolina, loggerhead occurrence is highly seasonal (CETAP, 1982; Lutcavage and Musick, 1985; Shoop and Kenney, 1992). South of Cape Hatteras, loggerheads are resident year-round. Based on aerial survey data, it is estimated that only 12 percent of all western North Atlantic loggerheads reside in the eastern GOMEX and that the vast majority of these individuals occur in western Florida waters (TEWG, 1998; Davis et al., 2000b).

Low water temperatures affect loggerhead turtle activity, and cold-stunned loggerheads have been found in various locales, including Long Island Sound, New York; Cape Cod Bay, Massachusetts; Indian River Lagoon, Florida; and at sites in Texas (Burke et al., 1991; Morreale et al., 1992; NOAA, 1993). Loggerheads become lethargic at about 13 to 15°C (55.4 to 59°F) and adopt a stunned floating posture in water around 10°C (50°F) (Mrosovsky,1980). Coles and Musick (2000) identified preferred sea surface water temperatures to range between 13.3 to 28°C (55.9 to 82.4°F) for loggerhead turtles off North Carolina. Cold-stunned loggerheads are often found between December and February offshore of Cape Lookout, North Carolina (Schwartz, 1989). Some loggerheads are believed to escape cold conditions by burying themselves in the bottom sediment; the reason for this is unknown. Over-wintering loggerheads may exhibit this behavior in Cape Lookout Bight, although this is yet to be confirmed (Schwartz, 1989). An age difference exists in the loggerhead's cold tolerance, with younger turtles being more resistant (Schwartz, 1978).

Loggerhead turtles nest almost exclusively in warm-temperate regions. Throughout the world, nesting on warm-temperate beaches is much more common than nesting in the tropics (TEWG, 2000). Beach temperatures may also determine sex of hatchlings; male hatchlings typically occur on cooler temperature beaches (Mrosovsky, 1980). Intraseasonal nesting patterns for females vary; some females may nest only once a season while others may nest several times (Webster and Cook, 2001).

Genetic evidence has shown that assemblages of benthic-feeding immature loggerheads on foraging grounds comprise a mix of subpopulations (Sears et al., 1995; TEWG, 1998; Epperly et al., 2001). Genetic analyses of stranded loggerheads have shown that the Northern (25 percent), South Florida (58 percent), and Yucatán (17 percent) subpopulations of loggerheads intermingle on foraging grounds in northeast U.S. waters (Rankin-Baransky, 1997). Many of the loggerheads feeding between northeastern Florida and North Carolina are derived from the South Florida (65 percent) and nearby Northern (19 percent) nesting subpopulations (Roberts et al., 2005). Epperly et al. (2001) reported that the northern nesting subpopulation accounts for 46 percent of the loggerheads in Virginia but only 25 to 28 percent of the loggerheads off the Carolinas. The south

Florida subpopulation also contributes significantly to loggerheads off the Carolinas (66 percent) and in North Carolina's Albemarle-Pamlico Estuarine Complex (Epperly et al., 2001). The genetic origins of benthic immature loggerheads in the GOMEX have not been determined (TEWG, 1998, 2000).

Atlantic Ocean, Offshore of the Southeastern United States

Loggerheads occur year-round in the VACAPES OPAREA, using waters of the OPAREA for foraging and transit to nesting beaches. Seasonal water temperatures influence loggerhead occurrence within the OPAREA. A high concentration of loggerheads occurs in shelf waters offshore of Maryland during the spring and northern North Carolina during the fall. During spring and fall, loggerheads are likely transiting the OPAREA to access summer foraging or overwintering habitats.

Loggerheads occur year-round in the CHPT OPAREA, using North Carolina waters for overwintering, foraging, and traveling to nesting beaches. Seasonal water temperatures influence loggerhead occurrence offshore North Carolina although loggerheads are resident year-round south of Cape Hatteras, NC. The occurrence trend shows a preference for shelf waters throughout the year; during the winter, loggerhead presence may extend further offshore. Spring and summer represent peak nesting time for loggerheads in North Carolina; during these seasons, individuals may travel across the OPAREA en route to nesting beaches.

Loggerheads occur year-round in the JAX/CHASN OPAREA, using the waters for overwintering, foraging, migrating, and traveling to nesting beaches. The occurrence records show a preference for shelf waters and are correlated with the Gulf Stream throughout the year. Spring and summer represent peak nesting time for loggerheads in the area; during these seasons, individuals may transverse the OPAREA en route to nesting beaches. Loggerheads migrate south to the warmer waters of the JAX/CHASN OPAREA (Hopkins-Murphy et al., 2003; Morreale and Standora, 2005) while waters just south of the OPAREA serve as an overwintering ground (Carr et al., 1980; Henwood, 1987).

Atlantic Ocean, Offshore of the Northeastern United States

In general, loggerhead turtles can be found during any season in both continental shelf and slope waters of the U.S. Atlantic from Cape Cod to the Florida Keys. In summer, the overall distribution of loggerheads likely extends into the Gulf of Maine and waters over the Scotian Shelf, with some individuals venturing as far north as Newfoundland. Loggerhead abundance in the area likely peaks during summer (Shoop and Kenney, 1992), with the largest numbers of individuals occurring in mid-continental shelf waters off New Jersey. At the onset of winter, the species' range is presumed to contract to waters south of where the Gulf Stream Current deflects off Cape Hatteras. Despite low levels of survey effort beyond the continental shelf break, loggerheads are commonly sighted in deep, offshore waters of the Mid-Atlantic Bight. However, it is in the region's continental shelf waters where loggerhead turtles are believed to most often concentrate (Shoop and Kenney, 1992; Epperly et al., 1995).

In winter, the vast majority of loggerhead encounters in U.S. Atlantic waters occur in areas well south of the Northeast OPAREAs. Most loggerheads overwinter in waters associated with the Gulf Stream from Cape Hatteras south (Epperly et al., 1995; Epperly et al., 1995). Strandings along Cape Cod and Long Island and sightings near the southern boundary of the Northeast OPAREAs provide evidence that small numbers of loggerheads may remain in the area during winter. Those individuals that do remain will likely be highly susceptible to cold-stunning and hypothermia, as winter water temperatures in the area often drop well below the species' thermal tolerance (Burke et al., 1991).

In spring, loggerhead turtles begin to migrate into the Northeast OPAREAs in April and May, as evidenced by the increase in sighting records from winter to spring. Loggerheads are likely to occur throughout the Atlantic City and Narragansett Bay OPAREAs and in the southern portion of the Boston OPAREA (off Cape Cod) during this season, but aren't likely to enter the northern sector of the Boston OPAREA (i.e., the waters of the Gulf of Maine) until mid-summer (Shoop and Kenney, 1992).

During summer, loggerhead turtles can occur in the area as far north as the Gulf of Maine, although the scientific literature, and the available sighting, stranding, and bycatch records indicate that they most commonly occur in waters over the continental shelf and slope south of Long Island (Shoop and Kenney, 1992). As water temperatures rise from July to September, loggerheads will move further north and inshore along the U.S. Atlantic coast. Shoop and Kenney (1992) estimated that a minimum of 8,000 to 11,000 loggerheads are present in northeastern U.S. waters each summer. The area of highest summer occurrence likely runs through the center of the Atlantic City OPAREA, encompassing waters over the mid-continental shelf from roughly Delaware Bay to Hudson Canyon. Juvenile loggerheads are regular visitors to the area during this season, often using the region's inshore and nearshore waters as developmental foraging habitats. Delaware Bay, Long Island Sound, and Cape Cod Bay are three of the most often utilized juvenile developmental habitats along the northeastern U.S. coast (Burke et al., 1991; Prescott, 2000; UDSG, 2000).

Based on the available sighting and bycatch data, loggerhead turtles are likely to occur in both continental shelf and slope waters of the Atlantic City and Narragansett Bay OPAREAs during fall. The large number of stranding records along the northeast U.S. coast from Cape Cod south indicates that loggerheads are also likely to be found in the southern portion of the Boston OPAREA during this season. As water temperatures drop from October to December, most loggerheads will emigrate from their summer developmental habitats and eventually return to warmer waters south of Cape Hatteras, where they will spend the winter months (Morreale and Standora, 1998). Areas of high fall occurrence probably occur south of the area in continental shelf waters off Cape Hatteras, as loggerheads are often concentrated in that area as they pass through (Keinath et al., 1996). Loggerheads that are unable to vacate inshore habitats such as Long Island Sound and Cape Cod Bay in the fall often end up stranding on the region's beaches as a result of hypothermia (Burke et al., 1991).

Gulf of Mexico

In general, loggerhead turtles can be found during all seasons in both continental shelf and slope waters of the GOMEX. The sea turtle occurrence data illustrate that loggerheads are the most often sighted and stranded species of sea turtle in the northern GOMEX throughout the year. Sighting and nesting surveys have demonstrated that the density and abundance of loggerhead turtles is much higher in the northeastern Gulf than in the northwestern Gulf (Fritts et al., 1983b;

Davis et al., 2000b). Adult loggerheads do not heavily utilize the beaches of the Texas and Louisiana as nesting habitats and juvenile loggerheads appear to primarily use the developmental habitats found in the northwestern Gulf (Landry and Costa, 1999). Loggerhead turtles are occasionally associated with offshore oil platforms and banks in the western portion of the area (Lohoefener et al., 1990; Gitschlag and Herczeg, 1994) but are more often documented in association with natural and artificial reefs off of Florida (Rosman et al., 1987; Davis et al., 2000b). Significant concentrations of loggerheads are likely found in the Key West OPAREA, although far less survey effort has taken place in those waters.

The occurrence of loggerhead turtles during winter is likely concentrated in the northeastern Gulf, in Alabama and Florida Panhandle shelf waters. This trend, however, may reflect the amount of survey effort expended over those waters. Loggerheads also occur in the deeper off-shelf waters from Texas to Florida during winter, although not as prevalently as in shelf waters. The high number of strandings along the central and southern Florida coasts as well as the numerous sighting records from the Florida Keys indicates that loggerheads are likely just as common in waters off southern Florida as they are off Alabama and the Florida Panhandle (Pensacola and Panama City OPAREAs) during this season. In fact, ocean waters off southern Florida and in the Key West Complex should be more suitable for loggerheads during winter since they are several degrees warmer in temperature. Winter sightings in the northwestern Gulf are less concentrated, yet they occur in both continental shelf and slope waters off Texas and Louisiana.

In spring, as evidenced by the available sighting, stranding, and incidental bycatch data, loggerheads can be found from inshore, estuarine waters to oceanic habitats far beyond the continental shelf break. It is likely that loggerhead turtles may be found in every Navy GOMEX OPAREA during this season. During spring months, loggerhead stranding activity along much of the south Florida and Panhandle coasts remains high. In addition, loggerhead nesting activity begins in several areas of the northern GOMEX, including south Texas, Alabama, the Florida Panhandle, and south Florida. Fritts et al. (1983b) sighted the highest numbers of loggerheads in the GOMEX during spring.

Loggerhead turtle abundance throughout the area likely peaks during summer, when water temperatures and nesting activity reach their highest levels. Occurrence of loggerheads is likely in all continental shelf waters of the area in summer. Sightings are common throughout the GOMEX continental shelf waters, including southeastern Florida and the Florida Keys. Strandings occur uniformly in the Florida Keys and much of the western Florida, Alabama, and Mississippi coasts. Nesting activity in Florida coastal counties and along Alabama shores remains at the same level as occurred in spring. Off-shelf occurrences are infrequent, possibly due to the movement of most loggerheads further north and inshore during summer months. Braun-McNeill and Epperly (2004) concluded that increases in nearshore loggerhead occurrences during summer months are more profound in more western GOMEX waters.

Based on the available sighting and bycatch data, loggerhead turtles continue to occur throughout the continental shelf waters of the GOMEX and southeastern Florida during fall. The highest concentrations of loggerheads in the area are predicted to occur in fall just offshore of Tampa Bay, with other aggregations occurring in waters along much of the inner Florida shelf to the Florida Keys. Loggerheads occur along much of the inner Texas and Louisiana shelf waters as well, although occurrences are not as likely off southern Texas and much of the Corpus Christi OPAREA due to a lack of documented sightings. Although nesting activity in the region tapers off significantly during fall, the post-nesting migrations of several individuals satellite-tagged on nesting beaches in the Gulf Islands indicate that adult loggerheads likely remain in continental shelf waters of the northern GOMEX throughout the season. Only when water temperatures drop dramatically at the onset of winter will most loggerheads move further offshore or to more southerly waters.

3.7.1.4 Kemp's Ridley Sea Turtles (*Lepidochelys kempii*)

Description – The Kemp's ridley is the smallest sea turtle; adult straight carapace length is approximately 65 cm (26 in) and adults weigh less than 45 kg (99 lb) (USFWS and NMFS, 1992). The carapace is round to somewhat heart-shaped and distinctly light gray.

Status – The Kemp's ridley turtle is classified as endangered under the ESA; it is considered the world's most endangered sea turtle (USFWS and NMFS, 1992). The worldwide population declined from tens of thousands of nesting females in the late 1940s to approximately 300 nesting females in 1985. From 1985 to 1999, the number of nests at Rancho Nuevo, Tamaulipas (eastern coast of Mexico) increased at a mean rate of 11.3 percent per year (TEWG, 2000).

Approximately 5,373 nests and 2,339 nesting females were recorded at Rancho Nuevo in 2003; however, these numbers represent a 94 percent decrease from historical records (Márquez-M. et al., 2005). In 2005, 6,947 nests were recorded in Rancho Nuevo (USFWS, 2005). Positive trends in 2005 were also recorded in other areas of the Mexican Gulf Coast at Barra del Tordo (701 nests) and Barra de Tepehuajes (1,610 nests). Nests at Veracruz decreased from 164 nests in 2002 to 62 nests in 2005 (USFWS, 2005). Nesting levels at Padre Island National Seashore in Texas, the site of a Kemp's ridley head-starting and imprinting program from 1978 to 1988, have shown a slow but steady rise throughout time. During 2002, 38 Kemp's ridley nests were recorded, increasing from 13 nests in 1998 and 16 nests in 1999 (Márquez-M. et al., 2005). In 2006, 64 nests were recorded there (NPS, 2006).

There are an estimated 3,900 to 8,100 juvenile Kemp's ridleys that utilize developmental habitats annually along the western North Atlantic coast (Seney and Musick, 2005).

Habitat Preferences – Kemp's ridley turtles occur in open-ocean and *Sargassum* habitats of the North Atlantic Ocean as post-hatchlings and small juveniles (e.g., Manzella et al., 1991). They move to benthic, nearshore feeding grounds along the U.S. Atlantic and Gulf coasts as large juveniles and adults (Morreale and Standora, 2005). Habitats frequently utilized include warm-temperate to subtropical sounds, bays, estuaries, tidal passes, shipping channels, and beachfront waters where its preferred food, the blue crab (*Callinectes sapidus*), is known to exist (Lutcavage and Musick, 1985; Landry and Costa, 1999).

Water temperature is a limiting factor in the distribution and abundance of Kemp's ridley turtles present in the North Atlantic Ocean. In temperature less than 13°C (55.4°F), Kemp's float, make awkward movements, and may even die of cold-stunning (Burke et al., 1991; Márquez-M., 1994). Several mechanism have been suggested for Kemp's ridley survival of cold temperatures during the winter; one hypothesis is migration to warmer waters while others theorize that these turtles bury themselves in mud bottoms to avoid the low temperatures (Márquez-M., 1994). Kemp's ridleys are likely only to be found along the mid-Atlantic coast from spring to fall but may be found throughout the waters of the South Atlantic Bight (SAB) and GOMEX year-round (Lazell, 1980; Lutcavage and Musick, 1985; Weber, 1995).

In addition to water temperature, habitat factors of critical importance to Kemp's ridley turtles include water depth and prey abundance. Using what is known about the affinity of this species for shallow coastal waters and their aversion to cold temperatures, scientists have developed a habitat suitability index (HSI) estimating the suitability of various habitats in the northwestern Atlantic and GOMEX for the species (Coyne et al., 1998). In this theoretical, quantitative model, the most optimal habitats for Kemp's ridleys are those with a bottom depth less than 10 m (32.8 ft) and a sea surface temperature between 22° and 32°C (71.6° and 89.6°F) (Coyne et al. 1998). A cycling of HSI model outputs by month for the Atlantic and Gulf coasts can be viewed at http://www.seaturtle.org/research/hsi.html.

Distribution **–** The Kemp's ridley is restricted to the North Atlantic Ocean (Marquez-M. 1994). Adults are largely confined to the GOMEX, with moderate numbers along the U.S. Atlantic Coast as far north as Nova Scotia (Lazell, 1980; Morreale et al., 1992). It is mostly juveniles that occupy the northern part of the range (Morreale and Standora, 2005), with juvenile Kemp's ridleys most often sighted along the eastern coast of Florida (Henwood and Ogren, 1987). There is evidence of transoceanic migrations, with some Kemp's ridleys reported as far east as northern Europe and the Mediterranean Sea (Brongersma, 1995; Tomás et al., 2003).

Oceanic transport of hatchling Kemp's ridleys is controlled primarily by hydrography in the GOMEX (Collard, 1990b). Upon leaving the nesting beach of Rancho Nuevo, hatchling Kemp's ridleys enter the Mexican Current, and are swept eastward into the northern GOMEX (Musick and Limpus, 1997). Many juveniles are retained in the northern Gulf until they migrate inshore to demersal habitat. Others may be carried south from the northern Gulf into the Loop Current, where they are swept into the Florida Current and, subsequently, the Gulf Stream (Musick and Limpus, 1997). Once they reach a size of approximately 20 to 30 cm, or 2 years of age, they actively migrate to neritic developmental habitats along the U.S. Atlantic Coast (Musick and Limpus, 1997). Alternatively, the North Atlantic Gyre may work in conjunction with the Gulf Stream to carry juveniles into the eastern North Atlantic Ocean, to areas such as the Azores and Madeira (Brongersma, 1995; Musick and Limpus ,1997).

Adults appear to remain in the GOMEX, with occasional occurrences in the Atlantic Ocean. Satellite-tracking of an adult Kemp's ridley of unknown sex showed a route from the GOMEX through the Florida Straits and into the Atlantic Ocean (Renaud and Williams, 2005). Movement by adult females in the GOMEX are expected to be more extensive than those of males, and likely influenced by foraging and reproductive needs; Renaud and Williams (2005) tracked one adult female from her foraging grounds offshore Louisiana to the nesting beach in Rancho Nuevo, Mexico. Adult male Kemp's ridleys exhibit small range movements and may reside on offshore nesting beaches year-round due to prey availability and mating opportunities (Shaver et al., 2005).

Environmental conditions play a major role in determining the number of Kemp's ridleys in an area. A decrease in air and surface water temperature in the fall, influenced by the passage of cold fronts, likely triggers Kemp's ridley seasonal migrations (Renaud and Williams, 2005). Migrations tend to take place in nearshore waters along the mid-Atlantic Coast; juvenile and adults typically travel within the 18 m (59 ft) depth contour (Renaud and Williams, 2005). This migratory corridor is a narrow band running within continental shelf waters, possibly spanning the entire length of the U.S. Atlantic Coast (Morreale and Standora, 2005).

Mature Kemp's ridleys likely forage along the eastern GOMEX and eastern coast of Florida (Henwood and Ogren, 1987; Schmid and Barichivich, 2005). Although (Renaud, 1995) indicated that adult Kemp's ridley turtles may travel along the entire Gulf Coast when looking for optimal foraging habitat, Schmid and Barichivich (2005) found adult Kemp's ridleys to establish site fidelity at foraging areas in coastal waters.

Nesting occurs primarily on a single nesting beach at Rancho Nuevo, Tamaulipas, on the eastern coast of Mexico (USFWS and NMFS, 1992), with a few additional nests in Texas, Florida, South Carolina and North Carolina (Meylan et al., 1990; Weber, 1995; Godfrey, 1996; Foote and Mueller, 2002; NPS, 2003).

Atlantic Ocean, Offshore of the Southeastern United States

Kemp's ridleys occur within the VACAPES OPAREA year-round although occurrence is most common during the summer. They are likely to occur from the shoreline to the 50-m (164-ft) isobath from spring through fall. Adults are not often found in waters deeper than 50-m (164-ft) (Byles, 1989). Water temperature is likely the most influential factor in the seasonal occurrence of Kemp's ridleys within the VACAPES OPAREA. Juvenile Kemp's ridleys are the second most common, after loggerheads, to use Virginia developmental habitat (Mansfield 2006). Kemp's ridley hatchlings may occur offshore near the eastern edge of the VACAPES OPAREA and Gulf Stream in *Sargassum*. Spring and fall appear to experience the greatest amount of strandings.

Kemp's ridleys occur within the CHPT OPAREA year-round although occurrence is most common during the winter and summer months. Water temperature is likely the most influential factor in the seasonal occurrence of Kemp's ridleys within the OPAREA. Kemp's ridley hatchlings may occur offshore near the eastern edge of the CHPT OPAREA and Gulf Stream in *Sargassum*. Spring and fall appear to experience the greatest amount of strandings.
Kemp's ridleys occur within the JAX/CHASN OPAREA year-round. Water temperature is an influential factor in the occurrence and distribution of Kemp's ridleys within the OPAREA. Additionally, increased survey efforts due to North Atlantic right whale surveys in the late fall and winter seasons greatly increase the number of sightings recorded during those seasons. Kemp's ridley hatchlings may occur offshore seaward of shelf break near the Gulf Stream in *Sargassum* and older animals, sub-adults and adults, may be found in the warm Gulf Stream waters during the colder months.

Atlantic Ocean, Offshore of the Northeastern United States

Overall, Kemp's ridley turtles could occur during any season in the continental shelf waters of the Northeast OPAREAs to as far north as Massachusetts Bay, with the highest concentrations likely occurring during summer in the western portion of the Atlantic City OPAREA. Sighting records for the remaining three seasons are sparse, yet the lack of sightings may be due to low sightability rather than low occurrence. Kemp's ridleys are very difficult to sight during aerial and shipboard surveys, especially at times of the year when sighting conditions are not optimal (Shoop and Kenney, 1992; Keinath et al., 1996). Generally, sighting conditions in the western North Atlantic Ocean are best during summer.

In winter, Kemp's ridley turtles may occur in the area infrequently (i.e., in very low numbers). Prior to the onset of winter, most Kemp's ridley turtles move to warmer waters further south or within the Gulf Stream Current (Keinath et al., 1996; Morreale and Standora, 1998). The only winter occurrences in the area are several strandings recorded on Long Island and Cape Cod. The stranding records and scientific literature suggest that some individuals remain. However, in most cases, these turtles will experience hypothermia and ultimately strand on the region's beaches (Burke et al., 1991; Morreale et al., 1992; Still et al., 2003).

The occurrence of Kemp's ridley turtles in the area likely remains low during spring. There are no spring sighting records, however, strandings along the beaches of Long Island and Cape Cod demonstrate that there is the potential for this species to be present in the area during spring. Satellite-tracking studies and in-water surveys have also provided conclusive evidence that Kemp's ridley turtles begin their northward seasonal movements into the area's waters from further south during this season. Kemp's ridley turtles begin arriving in Mid-Atlantic waters off New Jersey and New York in June; yet do not occur there in large numbers until the summer and fall months (Morreale and Standora, 1998).

Kemp's ridley turtles have been recorded in waters as far north as Massachusetts Bay during the summer, yet the majority of sightings in the area occur in continental shelf waters off New Jersey. Kemp's ridleys are likely to occur in these waters, as well as within Delaware Bay and Long Island Sound, where they are presumably preying on blue crabs, their preferred prey (UDSG, 2000). Cape Cod Bay has also been identified as an area of known summer concentration (Burke et al., 1993; Weber, 1995; Morreale and Standora, 1998; Prescott, 2000), so this species probably occurs in waters further north than the sighting records indicate (at least to Massachusetts Bay). Although few sighting records exist for Cape Cod Bay, it is identified as the northernmost summer feeding habitat for juvenile Kemp's ridleys in the western North Atlantic Ocean (Danton and Prescott, 1988; Still et al., 2002).

Based on the large numbers of strandings that are recorded along the coasts of Long Island and Cape Cod on an annual basis, it is likely that this species occurs in shelf waters from Cape Cod Bay south during fall (Danton and Prescott, 1988; Prescott, 2000; Still et al., 2002). Even though only one fall sighting record exists in the area, the scientific literature states that Kemp's ridley turtles generally occur in the area through October (Keinath et al., 1996; Morreale and Standora, 1998; UDSG, 2000). As water temperatures rapidly decline from October through December, Kemp's ridleys become increasingly susceptible to stranding as a result of hypothermia. Kemp's ridleys that are unable to emigrate from the area in early fall often suffer from cold-stunning and then strand on the region's beaches (Burke et al., 1991; Morreale et al., 1992; Still et al., 2003).

Gulf of Mexico

Kemp's ridley turtles primarily occur in shallow (less than 50 m [164 ft]) continental shelf waters of the northern GOMEX year-round. Tidal passes and beachfront environments are their most preferred habitats in this region (Landry and Costa, 1999). The low number of sighting records for the area is likely due to low survey effort and poor sightability of this species rather than low to no occurrence; Kemp's ridley turtles are very difficult to sight during aerial and shipboard surveys, especially at times of the year when sighting conditions are not optimal (Shoop and Kenney, 1992; Keinath et al., 1996). It is likely that Kemp's ridley turtles may be observed in all GOMEX OPAREAs during the year, particularly in the inner shelf waters.

Kemp's ridley turtle sightings in the area are sparse during winter, with the most numerous cluster occurring off the Florida Panhandle. Numerous stranding records from southern Florida; several bycatch, nest, and stranding records along the Texas coast; and sighting records off Louisiana suggest that these turtles may be found in continental shelf waters of the northern GOMEX and southeastern Florida. This conclusion is supported by the information from marine surveys and platform observation programs that indicate little prolonged utilization of offshore habitat by this species in winter (Landry and Costa, 1999). It is surprising that most winter sightings occur in the northernmost waters of the GOMEX, as the suitability of those waters in winter is low (Coyne et al., 2000). Movement data from tagged individuals suggests that the species' attraction to nearshore habitats weakens with the onset of cooler water temperatures.

The occurrence of Kemp's ridley turtles in the area likely remains low in waters beyond the continental shelf during spring. However, regular nesting occurs along the coast of Texas and the numerous strandings along the coast of Florida demonstrate the continued presence of Kemp's ridley turtles in nearshore waters of the northern GOMEX. As these waters warm from April to June, the suitability of nearshore habitats increases from low to high (Coyne et al., 2000). Kemp's ridleys nesting in south Texas either come from Mexican waters or from northern GOMEX waters. Individuals coming from the east likely travel in close proximity to the shore, as evidenced by recaptures of pre- and post-nesting females at Sabine and Calcasieu Passes along the upper Texas/Louisiana coasts (Landry and Costa, 1999). Spring nesting has also been documented along the coast of southern Florida, although these occurrences are rare (Foote and Mueller, 2002).

The suitability of continental shelf habitats in the northern GOMEX and off southeastern Florida peaks during summer, while the suitability of off-shelf habitats remains poor to unsuitable (Coyne et al., 2000). As a result, nearly all sighting and bycatch records continue to be recorded in continental shelf waters of the area from Texas through Florida. Kemp's ridleys may occur ubiquitously throughout shelf waters of the entire area. Shrimp and blue crabs, the preferred prey of Kemp's ridleys, are both very abundant off southern Louisiana during summer months (Manzella et al., 1988) and the coastal waters off southern Louisiana and western Florida have also been documented as important developmental regions for juvenile turtles (Rudloe et al., 1991; Schmid et al., 2002). Kemp's ridley turtles may likely occur in all OPAREAs except the New Orleans OPAREA during summer.

Line-transect survey effort over Kemp's ridley suitable habitat in the area is most extensive during fall, with a large amount of that effort directed to the west Florida shelf. Areas of highest

Kemp's ridley occurrence, as shown through the occurrence records, include the Cedar Keys region, waters within and offshore of Tampa Bay, and nearshore waters off Monroe County in southwestern Florida. These are areas where adult Kemp's ridleys, which are more easily recognizable during aerial and shipboard surveys, likely congregate throughout the year. Since juveniles are known to prefer nearshore waters of the northwestern GOMEX year round (Renaud, 1995), it is likely that occurrence records in Texas and Louisiana waters represent a different size-class than those recorded for Florida nearshore waters. The likely explanation for fewer sighting records in the preferred waters of juvenile Kemp's in the northwestern Gulf during this season is that juvenile Kemp's ridley turtles are less likely to be spotted during sighting surveys. Nevertheless, Kemp's ridleys are likely as abundant in those waters as they are off Florida.

3.7.1.5 Olive Ridley Sea Turtle (*Lepidochelys olivacea*)

Description **–** The olive ridley is a small, hard-shelled sea turtle named for its olive green colored shell. Adults often measure between 60 and 70 cm (24 and 28 in) in carapace length (NMFS and USFWS, 1998). The olive ridley has a smaller head, a narrower carapace, and several more lateral carapace scutes than does its relative, the Kemp's ridley turtle.

Status **–** Olive ridleys are classified as threatened under the ESA, although the Mexican Pacific coast population is classified as endangered. Since listing under the ESA, a general decline in the abundance of this species has occurred (NMFS and USFWS, 1998). For example, nesting populations in the western North Atlantic Ocean have declined more than 80 percent since 1967 (Reichart, 1993). However, in terms of absolute numbers, the olive ridley is considered the most abundant of the world's sea turtles, although there are no current estimates of worldwide abundance.

Habitat Preferences **–** Olive ridley turtles typically inhabit offshore waters, foraging either at the surface or at depth (up to 150 m [492 ft]). Strangely enough, the habitat preferences of the olive ridley more closely parallel those of the leatherback sea turtle rather than those of its relative, the Kemp's ridley (NMFS and USFWS, 1998). Olive ridleys and leatherbacks both occupy oceanic habitats and both nest primarily on the Pacific shores of the American tropics and in the Atlantic along the shores of the Guianas. Both species also nest in moderate numbers in tropical West Africa and southern Asia and in relatively small numbers elsewhere (both rarely nest in Australia and on other smaller oceanic islands in the Pacific Ocean).

Distribution **–** The olive ridley sea turtle is a pantropical species, occurring worldwide in tropical and warm temperate waters. In the Atlantic Ocean, the olive ridley occurs along the coasts of both Africa and South America but probably not in great abundance. Atlantic olive ridleys nest primarily in the French Guiana, Suriname, and Guyana; however, they are rarely found in the Caribbean Sea and have been documented in Puerto Rico, the Dominican Republic, and Cuba (Foley et al., 2003).

Atlantic Ocean, Offshore of the Southeastern United States

The olive ridley sea turtle is not expected to occur within the Atlantic Ocean, offshore of the southeastern United States.

Atlantic Ocean, Offshore of the Northeastern United States

The olive ridley sea turtle is not expected to occur within the Atlantic Ocean, offshore of the northeastern United States.

Gulf of Mexico

There are no olive ridley sighting records available for the area. Only three occurrences have ever been documented in the vicinity of the GOMEX, all of which are strandings. Between 1999 and 2001, three olive ridley turtles stranded between Miami-Dade County and Marathon in the Florida Keys (one in summer, two in fall). Two were confirmed to be adult males, while the other was determined to be an early juvenile male. Originally identified as Kemp's ridley turtles, these individuals were later reclassified as olive ridleys following a review of photographic data and comparison of genetic samples (Foley et al., 2003). These three stranding records represent the northernmost known occurrences of olive ridleys in the northwestern Atlantic Ocean and should, therefore, be deemed as extralimital. In the western North Atlantic, the species' center of distribution is located several thousands of kilometers to the south along the northern coast of South America.

3.7.1.6 Leatherback Sea Turtles (*Dermochelys coriacea*)

Description **–** The leatherback turtle is the largest living sea turtle. This species is placed in a separate family from all other sea turtles, in part because of its unique carapace structure. A leatherback turtle's carapace lacks the outer layer of horny scutes possessed by all other sea turtles; it is instead composed of a flexible layer of dermal bones underlying tough, oily connective tissue and smooth skin. The body of a leatherback is barrel-shaped and tapered to the rear with seven longitudinal dorsal ridges, and it is almost completely black with variable spotting. All adults possess a unique pink spot on the dorsal surface of their head; this marking can be used by scientists to identify specific individuals (McDonald and Dutton, 1996). Adult curved carapace lengths (CCL) range from 137 to 183 cm (54 and 72 in). Adult leatherbacks typically weigh between 200 and 700 kg (441 and 1,543 lbs) (NMFS and USFWS, 1992), although larger individuals are documented (Eckert and Luginbuhl, 1988).

Status **–** Leatherback turtles are listed as endangered under the ESA (NMFS and USFWS, 1992). Counts of nesting females typically provide the best available index of leatherback sea turtle population status; the largest leatherback populations are located in the western Atlantic Ocean and Caribbean Sea regions (Spotila et al., 1996). The most recent summary of sea turtle nesting status in the Atlantic Ocean estimates approximately 1,437 to 1,780 (individuals occurring throughout the Caribbean Islands, with an estimated global population of 34,500 females (Spotila et al., 1996). Although leatherback nesting in Florida was once considered rare, leatherback nesting numbers are now significant in this state and have increased over time (Meylan et al., 2006). Populations nesting in Culebra, Puerto Rico, and St. Croix, U.S. Virgin Islands are also believed to be increasing due to heightened protection and monitoring of the nesting habitat over the past 20 years (Hillis-Starr et al., 1998; Fleming, 2001; Thompson et al., 2001; Dutton et al., 2005).

Habitat Preferences – Throughout their lives, leatherbacks are essentially oceanic, yet they enter into coastal waters for foraging and reproduction. There is limited information available regarding the habitats utilized by post-hatchling and early juvenile leatherbacks as these age classes are entirely oceanic (NMFS and USFWS, 1992). These life stages are restricted to waters greater than 26°C (78.8°F) and, therefore, spend much time in tropical waters (Eckert, 2002). They are not considered to associate with *Sargassum* or other flotsam, as is the case for all other sea turtles species in the North Atlantic Ocean (NMFS and USFWS, 1992). Upwelling areas, such as the Equatorial Convergence Zones, serve as nursery grounds for post-hatchling and early juvenile leatherbacks; these areas also provide a high biomass of gelatinous prey (Musick and Limpus, 1997).

Late juvenile and adult leatherback turtles are known to range from mid-ocean to continental shelf and nearshore waters (Schroeder and Thompson, 1987; Shoop and Kenney, 1992; Grant and Ferrell, 1993). Juvenile and adult foraging habitats include both coastal feeding areas in temperate waters and offshore feeding areas in tropical waters (Frazier, 2001). The movements of adult leatherbacks appear to be linked to the seasonal availability of their prey and the requirements of their reproductive cycle (Collard, 1990a; Davenport and Balazs, 1991).

Leatherbacks commonly nest on wide sandy beaches which are inclined and backed with vegetation (Eckert, 1987; Hirth and Ogren, 1987). Many eggs may be lost to erosion due to their preference for high-energy, steeply sloped beaches (NMFS and USFWS, 1992). During the nesting season (March through July), females are highly mobile and often move between several beaches. Results from tagging studies have indicated that Caribbean leatherbacks often nest on multiple islands during a nesting season (Eckert et al., 1989; Keinath and Musick, 1993).

Distribution – Leatherback turtles occur circumglobally in tropical, subtropical, and warm-temperate waters throughout the year and in cooler temperate waters during warmer months (NMFS and USFWS, 1992; James et al., 2005a). Leatherbacks in the North Atlantic Ocean are broadly distributed from the Caribbean region to as far north as Nova Scotia, Newfoundland, Labrador, Iceland, the British Isles, and Norway (Bleakney, 1965; Brongersma, 1972; Threlfall, 1978; Goff and Lien, 1988). This species migrates further and moves into cold waters more than any other sea turtle species (Bleakney, 1965; Lazell, 1980; Shoop and Kenney, 1992).

In the North Atlantic Ocean, leatherbacks show strong seasonal distribution patterns and make extensive movements between temperate and tropical waters (James et al., 2005a, 2005b, 2005c). One leatherback caught in the Chesapeake Bay was tagged, released, and then caught again over a year later off southern Cuba, for a minimum distance of 2,168 km (Keinath and Musick, 1990). Leatherbacks tagged on Caribbean nesting beaches travel great distances across the North Atlantic Ocean and vary in pan-oceanic movements. Some individuals travel north to foraging habitats off the Atlantic coasts of the United States and Canada. Others travel northeast to temperate waters surrounding the British Isles and the Azores while some individuals travel east to the coast of Africa (Hays et al., 2004). Female leatherbacks tagged in the USVI, Colombia, French Guiana, and Costa Rica have been found stranded along the Atlantic and Gulf coasts of the United States (Thompson et al., 2001). Tagging studies also indicate many variations in overwintering and onshore-offshore occurrence patterns (Lee and Palmer, 1981). For example, a leatherback satellite-tagged on a Florida nesting beach traveled directly to the coast of Virginia after her last nest of the season; while there, she remained within 100 km of shore during her entire four-month stay (CCC, 2002).

According to aerial survey data, there is a northward movement of individuals along the southeast coast of the United States in the late winter/early spring. In February and March, most leatherbacks along the U.S. Atlantic coast are found in the waters off northeast Florida. By April and May leatherbacks begin to occur in larger numbers off the coasts of Georgia and the Carolinas (NMFS, 1995; NMFS, 2000). In late spring/early summer, leatherbacks appear off the mid-Atlantic and New England coasts, while by late summer/early fall, many will have traveled as far north as the waters off eastern Canada (CETAP, 1982; Shoop and Kenney, 1992; Thompson et al., 2001). Leatherbacks may also exhibit east-west movement patterns, migrating seasonally from coastal waters to offshore in the late summer; leatherbacks may be observed in the mid-Atlantic Bight during this time (Eckert, 2006). Eckert et al. (2006) found leatherback foraging areas in the western Atlantic to be located on the continental shelf (30 to 50°N) as well as offshore (42°N, 65°W). The location of these foraging areas changed seasonally. From March through November, foraging areas occurred on the North American continental shelf yet shifted to off-shelf waters from December through February (Eckert et al., 2006).

North Carolina waters may be utilized by foraging leatherbacks or individuals in transit. The coastal area immediately adjacent to Cape Hatteras is recognized as a migratory pathway for leatherbacks (Lee and Palmer, 1981). Leatherbacks are observed in areas of high jellyfish concentrations along the Carolina coastlines (Grant and Ferrell, 1993). Jellyfish prey occurs south of Cape Hatteras from May to November; at this time, individuals congregate along the coast and forage in areas such as North Topsail Island, North Carolina and Myrtle Beach, South Carolina (Grant and Ferrell, 1993).

Leatherback nesting in the western North Atlantic is restricted to coarse-grained beaches in subtropical and tropical latitudes (NMFS and USFWS, 1992). Nesting occurs along the coasts of North, Central, and South America (from the southeastern United States to Brazil) and throughout the Greater and Lesser Antilles. The most significant nesting populations occur at French Guiana, Suriname, Guyana, Colombia, Panama, Costa Rica, and Trinidad (Thompson et al., 2001). Nesting populations at Culebra, Puerto Rico and St. Croix, USVI are on the rise (Dutton et al., 2005; Eckert, S.A., WIDECAST, pers. comm., February 28, 2006). In the northern Caribbean, Sandy Point National Wildlife Refuge, St. Croix, U.S. Virgin Islands is the principal nesting beach for leatherbacks (Hillis-Starr et al., 1998). Leatherback nesting along the East Coast most commonly takes place in Florida; although previously rare, nesting numbers are significant in this area (Meylan et al., 2006).

Atlantic Ocean, Offshore of the Southeastern United States

Seasonal movements of large subadult and adult leatherbacks have been documented by aerial surveys along the U.S. Atlantic Coast (Shoop and Thompson, 1983; Schroeder and Thompson, 1987; NMFS, 1995); however, leatherbacks are likely not constrained by seasonal temperature variations. Leatherback occurrence is seasonal along the U.S. Atlantic coast, with the number of sightings along the northern area of the coast increasing from winter to summer.

Leatherbacks are found year-round in the VACAPES OPAREA with the greatest occurrence during the summer. As evidenced by a combination of sighting and bycatch records, this species may occur in VACAPES OPAREA shelf waters or offshore waters just beyond the shelf break. The greatest concentrations of leatherbacks likely to occur in the OPAREA vary seasonally by location. For example, leatherback presence is expected to peak off Virginia in May and July and in North Carolina from mid-April through mid-October (Keinath et al., 1996).

Leatherbacks are found year-round in North Carolina waters (Schwartz, 1989); within the CHPT OPAREA, the majority of leatherback sightings occur on the continental shelf, although several bycatch records exist for waters beyond the shelf break. As evidenced by a combination of sighting and bycatch records, this species occurs in offshore waters, especially north of Cape Lookout (Lee and Palmer, 1981; Schwartz, 1989). The greatest concentrations of leatherbacks are likely to occur in North Carolina from mid-April through mid-October (Keinath et al., 1996); the greatest abundance of leatherbacks in the CHPT OPAREA is likely during the spring and summer.

Leatherbacks are found year-round in the JAX/CHASN OPAREA, occurring in the shallow waters over the continental shelf (Lee and Palmer, 1981) or in offshore waters (Schwartz, 1989). The JAX/CHASN OPAREA and vicinity may be used by leatherbacks for foraging, transit, or nesting purposes. For example, a post-nesting leatherback, satellite-tagged on a Florida nesting beach in 2000, traveled along the U.S. Atlantic Coast to New Jersey, passing through the JAX/CHASN OPAREA on her northward migration (Eckert et.al., 2005). Leatherback turtles are generally concentrated off the northeastern Florida coast during the winter beginning in November and December (NMFS, 1995).

Atlantic Ocean, Offshore of the Northeastern United States

Overall, leatherback turtles could occur within the area during any season, although they are most prevalent during summer. Large concentrations of leatherbacks are likely to be found in the following portions of the area during summer: off southern New Jersey, off the southeastern end of Long Island, and off southern Nova Scotia. Due to their highly evolved thermoregulatory capabilities, leatherbacks are frequently encountered in waters far beyond the northern and eastern extents of the area, yet many individuals, especially juveniles, remain in tropical or subtropical waters of the Atlantic Ocean throughout the year (Shoop and Kenney, 1992; Eckert, 2002). Although the available sighting records indicate a likely preference for continental shelf waters of the area, an abundance of incidental bycatch records shows that this species may also be found in deeper waters beyond the shelf break, where survey effort is minimal. As leatherbacks are the largest and most easily identifiable sea turtles, it is feasible that the sighting data accurately depict the species' actual occurrence within portions of the area that are adequately surveyed.

Leatherback turtles appear to be rare inhabitants of the area during winter. There are two winter sighting records off Cape Cod and a handful of stranding records along the northeast U.S. coast. During winter months, the vast majority of leatherback turtles in the Atlantic Ocean are likely found in tropical and subtropical waters located a good distance south of the area (e.g., in the Caribbean Sea or off Florida) (Thompson et al., 2001). As evidenced by sighting and bycatch records, some individuals may occur in continental slope waters off Cape Hatteras that are associated with the Gulf Stream.

In spring, leatherback turtles begin to appear in greater numbers off the northeastern U.S. coast. The sighting records indicate an occasional presence of leatherbacks in waters as far north as the Gulf of Maine. The large number of incidental bycatch records in waters beyond the continental shelf break demonstrates that this species may be primarily oceanic during the spring, choosing to inhabit warmer waters that are proximal to the Gulf Stream Current rather than cooler waters closer to shore. Shoop and Kenney (1992) observed that leatherback turtle sightings off the northeast United States most often occurred around the 2,000-m (6,562-ft) isobath during spring.

Leatherback turtle abundance increases dramatically in the Northeast OPAREAs waters during summer, as evidenced by the large number of sighting and bycatch records located over the region's continental shelf. Monthly sighting frequencies in northeastern U.S. waters peak at the end of summer, as an estimated minimum of 100 to 900 individuals take up residence in the area (Shoop and Kenney, 1992). During this season, leatherbacks can occur as far north as the waters off Newfoundland and Labrador (Bleakney, 1965; Goff and Lien, 1988). Leatherbacks appear to move closer to shore during summer, as nearshore water temperatures rise. At this time of year, leatherbacks commonly occur around the mouths of the region's bays and sounds, feeding on large aggregations of jellyfish found in those waters (James and Herman, 2001).

During fall, leatherbacks may continue to occur in the Northeast OPAREAs waters as far north as the Gulf of Maine and the Scotian Shelf. Thomspon et al. (2001) note that leatherbacks are found in Canadian waters through October, after which they begin their southward migration to warmer waters. From Georges Bank south to Cape Hatteras, a large number of fall sightings and bycatches have been recorded in waters along the continental shelf break. This clustering of records could imply that the continental shelf break serves as an important geographical feature that migrating leatherbacks follow when returning to more tropical waters prior to winter. However, it could also indicate a concentration of survey and fishing effort in those waters. Of note are the multiple stranding records that occur along the New Jersey, New York, and southern New England coasts during this season. Based on the entire set of occurrence data (sightings, strandings, and bycatches), as well as this species' broad habitat preferences, leatherbacks probably occur throughout the area during fall.

Gulf of Mexico

Overall, the leatherback turtle is the most oceanic of all sea turtle species occurring in the area. The high number of sighting and bycatch records occurring beyond the continental shelf is evidence of this species' habitat preference. Leatherbacks use the deep, offshore waters of the area (especially waters in the vicinity of DeSoto Canyon) for feeding, resting, and as migratory corridors (Landry and Costa, 1999; Davis et al., 2000b). Leatherbacks can also occur in shallow waters on the continental shelf, especially during nesting season; during aerial surveys off Naples, eight of nine leatherback sightings occurred in waters less than 50 m (164 ft) deep (Fritts et al., 1983b). Leatherbacks have been observed feeding on dense aggregations of jellyfish in nearshore waters off the Florida Panhandle, the Mississippi River Delta, and the Texas coast (Leary, 1957; Collard 1990a; Lohoefener et al. 1990). Leatherbacks may also enter the nearshore waters of the northern Gulf to nest. In recent years, low levels of nesting activity have been documented on both Florida Panhandle and south Florida beaches (LeBuff, 1990; Meylan et al., 1995). The distribution of sighting records in the area supports the pattern of leatherback occurrence in the northern GOMEX being fairly similar throughout the year suggested by Davis et al., 2000b.

The occurrence of leatherback turtles during winter is fairly patchy with occurrence most likely in the deeper waters off the continental shelf throughout the northern Gulf. The winter occurrence of this species may also include the outermost shelf waters off western Florida and Louisiana as well but it is unlikely that leatherbacks will occur in the inner shelf waters off Texas or Louisiana. Occurrence records show that leatherbacks occur in the shallow waters of the Florida Keys and in the northern part of the Key West OPAREA during winter. A slightly higher occurrence is expected along the shelf break waters of central-western Florida. Sparse winter stranding records have been documented only along the west Florida coast, which may imply that leatherbacks are rare inhabitants of these continental shelf waters (Landry and Costa, 1999) or may signify that leatherbacks are not as susceptible to stranding in winter as hard-shelled sea turtles due to their advanced thermoregulatory capabilities. Survey effort is lowest during winter, particularly off western Florida, so the occurrence of this species may not be definitely defined for this season.

While occurrence records indicate that leatherbacks occur primarily in the waters of the north-central Gulf during spring, especially in deeper waters well off the shelf, nesting records and rare sighting records indicate that leatherbacks also occur off southern Florida as well. It is unlikely that this species will be observed in the far western Gulf or in the Corpus Christi OPAREA during this season. The increase in the number of incidental bycatch events in waters far beyond the continental shelf break likely indicates an increase in fishing activity in those waters rather than an increase in leatherback abundance in deep waters. At this time of year leatherback nesting commences on Florida beaches adjacent to the area and small numbers of female adult leatherbacks will enter the coastal waters of the northeastern GOMEX in order to reproduce. However, since spring survey effort over these nearshore waters is minimal, occurrences are rarely recorded. Similar to winter, leatherback occurrence on the Texas shelf is unlikely but occurrence is likely in the New Orleans, Pensacola, and Panama City OPAREAs.

A distributional shift of leatherback turtles inshore and eastward appears to occur in the summer, with an increasing number of sightings located in the shallower shelf waters of the northeastern Gulf. No occurrence records are available for the waters off Texas or southern Florida, despite an increase in survey effort over those areas during this season. It is unlikely, therefore, that leatherbacks will occur in Texas waters during summer. Although not supported by the presence of bycatch or stranding records, the likelihood that leatherbacks may occur, at least rarely, in southern Florida shelf waters is increased due to the location of known nesting activity in Palm Beach County, southwestern Florida. Adult leatherbacks that nest along the Florida Panhandle likely utilize DeSoto Canyon as a post-nesting habitat due to its close proximity to the shore. Leatherbacks occupy the deeper waters of the central Gulf as well during this season as supported by the bycatch and sighting records. Occurrence in the Corpus Christi and Key West OPAREAs during this season is unlikely.

During fall, leatherbacks exhibit a patchy occurrence throughout the northern Gulf, inhabiting continental shelf waters off Louisiana, Mississippi, Alabama, and Florida with occurrence not likely in the inner shelf waters off western Louisiana and northern Texas. Leatherbacks also occur in the deepest waters of the central and western GOMEX (as evidenced by bycatch records) as well as off the Dry Tortugas. A noteworthy difference in the occurrence of leatherbacks during fall is the potential occurrence of this species in the shelf waters off central Texas and the northern part of the Corpus Christi OPAREA. The very patchy occurrence of leatherbacks in western Florida waters is supported by the results of dedicated aerial surveys(e.g., NMFS-SEFSC, 1994) in which few leatherbacks were recorded during this season, indicating that leatherbacks likely do not inhabit inner Florida shelf waters with any regularity during any season.

3.7.2 Threatened and Endangered Sea Turtles

All six sea turtle species found along the East Coast and in the GOMEX are listed as threatened or endangered (see Table 3-6 for ESA status of sea turtle species).

- Green sea turtle (*Chelonia mydas*) – endangered (while green sea turtles are listed as threatened, the Florida and Mexican Pacific coast nesting populations are listed as endangered)
- Hawksbill sea turtle (*Eretmochelys imbricata*) – endangered
- Loggerhead sea turtle (*Caretta caretta*) – threatened
- Kemp's (Atlantic) ridley sea turtle (*Lepidochelys kempii*) – endangered
- Olive ridley sea turtle (*Lepidochelys oliveacea*) – threatened
- Leatherback sea turtle (*Dermochelys coriacea*) – endangered

3.7.3 Turtle-Excluder Devices

Perhaps the most important step forward for sea turtles came in 1989, when all shrimpers in the United States were required to use special "turtle-excluder devices" (TEDs), which permit turtles accidentally caught in nets to escape through a trap door. Before TEDs were required, an estimated 150,000 sea turtles died each year when shrimp nets entrapped them and the animals drowned (Sea Turtle Restoration Project, 2007). The use of TEDs in the shrimp fishery is estimated to reduce sea turtle bycatch by approximately 97 percent (NOAA, 2004). In South Carolina waters, mortality was reduced by approximately 44 percent in the law's first four years (Gibbons, 2008).

3.7.4 Marine Turtle Protection Act

The FWC has established a Marine Turtle Protection Act that, like the ESA, regulates and prohibits the taking, killing, disturbing, mutilating, molesting, harassing, or destroying of any marine turtle. Furthermore, a permit must be obtained prior to conducting any activity involving marine turtles (FWC, 2007).

3.8 ESSENTIAL FISH HABITAT

3.8.1 Description of EFH

The Magnuson-Stevens Fishery Conservation and Management Act of 1976 (Magnuson-Stevens Act) (16 U.S.C. 1801 *et seq.*) established jurisdiction over marine fishery resources within the U.S. Exclusive Economic Zone. The Magnuson-Stevens Act mandated the formation of eight fishery management councils (FMC), which function to conserve and manage certain fisheries within their geographic jurisdiction. The Councils are required to prepare and maintain a Fishery Management Plan (FMP) for each fishery that requires management. Amendments contained in the Sustainable Fisheries Act of 1996 (Public Law 104-267) require the councils to identify Essential Fish Habitat (EFH) for each fishery covered under a FMP. EFH is defined as the waters and substrate necessary for spawning, breeding, or growth to maturity (16 U.S.C. 1802[10]). The term “fish” is defined as “finfish, mollusks, crustaceans, and all other forms of marine animals and plant life other than marine mammals and birds.” NMFS further clarified EFH (50 CFR 600.05 through 600.930) by the following definitions:

- **Waters**: Aquatic areas and their associated physical, chemical, and biological properties that are used by fish and may include aquatic areas historically used by fish where appropriate.
- **Substrate**: Sediments, hard bottoms, structures underlying the waters, and associated biological communities.
- **Necessary**: The habitat required to support a sustainable fishery and the managed species’ contribution to a healthy ecosystem.
- **Spawning, breeding, feeding, or growth to maturity**: Stages representing a species’ full life cycle.

In addition to the regional FMCs, the Atlantic States Marine Fisheries Commission (ASFMC), Gulf States Marine Fisheries Commission (GSMFC), and NMFS also have management responsibilities for certain fisheries. The ASFMC is a consortium of the 15 coastal states from the Atlantic coast of Florida through Maine that manages fish in state waters. The ASMFC currently manages 22 Atlantic coastal fish species or species groups. Similarly, the GSMFC is an organization of five states from the Gulf coast of Florida to Texas that manages fishery resources in state waters of the Gulf of Mexico. The GSMFC provides coordination and administration for a number of cooperative state/federal marine fishery resources. NMFS has jurisdiction over highly migratory species in federal waters off the U.S. Atlantic coast and GOMEX. Typically, the ASFMC, GSMFC, and NMFS work closely with regional Councils in preparing and implementing fishery management strategies.

In addition to establishing EFH, the Magnuson-Stevens Act also directs NMFS and the FMCs to characterize Habitat Areas of Particular Concern (HAPCs). HAPCs are subsets of EFH that are rare, especially ecologically important, particularly susceptible to human-induced degradation, or located in environmentally stressed areas (50 CFR 600.815(a)(8). HAPCs typically include high-value intertidal and estuarine habitats, offshore areas of high habitat value or vertical relief, and habitats used for migration, spawning, and rearing of fish and shellfish.

Managed fish species may be categorized as temperate, subtropical-tropical, or highly migratory species. The FMCs classify EFH for temperate and subtropical-tropical managed species in terms of five basic lifestages: (1) Eggs, (2) Larvae, (3) Juveniles, (4) Adult, and (5) Spawning Adult. Eggs are those individuals that have been spawned but not hatched and are completely dependent on the egg's yolk for nutrition. Larvae are individuals that have hatched and can capture prey, while Juveniles are those individuals that are not sexually mature but possess fully formed organ systems that are similar to adults. Adults are sexually mature individuals that are not necessarily in spawning condition. Finally, spawning adults are those individuals capable of spawning.

Although the individual lifestage terms and definitions are the same as those defined by the FMCs, NMFS categorizes the lifestages of managed tuna, swordfish, and billfish somewhat differently, resulting in three categories that are based on common habitat usage by all lifestages in each group: (1) Spawning Adults, Eggs, and Larvae; (2) Juveniles and Subadult; and (3) Adult. Subadults are those individuals just reaching sexual maturity. The category of Spawning Adult, Eggs, and Larvae is associated with spawning location and the circulation patterns that control the distribution of the eggs and larvae.

NMFS uses a different lifestage classification system for sharks; the system bases the lifestage combinations on the general habitat shifts that accompany each developmental stage. The three resulting categories are: (1) Neonate and Early Juvenile (including newborns and pups less than one year old), (2) Late Juvenile and Subadult (age one to adult), and (3) Adult (sexually mature sharks). In Amendment 1 to the Fisheries Management Plan for the Atlantic Tunas, Swordfish, and Sharks, the first two lifestages were modified as follows: the Neonate and Early Juvenile category was renamed "Neonate," which primarily includes neonates and small young-of-the-year sharks; and the Late Juveniles and Subadults category was renamed "Juveniles," which includes all immature sharks from young to late juveniles.

Of the eight FMCs, four (New England FMC, Mid-Atlantic MFC, South Atlantic FMC, and Gulf of Mexico FMC) have geographic areas of jurisdiction within the AFAST Study Area. In addition, NMFS has jurisdiction over highly migratory species throughout the Study Area. The fisheries and Management Units (individual species or groups of species managed through a FMP) for which EFH has been established are listed in Table 3-7.

Table 3-7. Fish Species and Management Units for which Essential Fish Habitat has been Identified in the AFAST Study Area

New England Fishery Management Council Jurisdiction
Northeast Multispecies Management Unit (15 species)[1, 6]
Small Mesh Multispecies (3 species)
Atlantic Sea Scallop
Atlantic Herring[2]
Monkfish[3]
Deep-Sea Red Crab
Northeast Skate Complex Management Unit (7 species)
Atlantic Spiny Dogfish[4]
Atlantic Salmon
Mid-Atlantic Fishery Management Council Jurisdiction
Atlantic Mackerel, Squid, and Butterfish Management Unit (4 species)
Bluefish[5]
Atlantic spiny dogfish[4]
Surfclam and Ocean Quahog management Unit (2 species)
Summer Flounder, Scup, and Black Sea Bass Management Unit (3 species)[6, 7]
Tilefish
Monkfish
South Atlantic Fishery Management Council Jurisdiction
Coastal Migratory Pelagics (5 species)[8]
Coral, Coral Reefs, and Live/Hardbottom[9]
Dolphin/Wahoo
Golden Crab
Sargassum
Shrimp (5 species)
South Atlantic Fishery Management Council Jurisdiction Cont'd
Snapper-Grouper Complex Management Unit (73 species)[7]
Red Drum[10]
Calico Scallop
Spiny Lobster[9]
Gulf of Mexico Fishery Management Council Jurisdiction
Coastal Migratory Pelagics (7 species)[8]
Coral and Coral Reefs (over 300 species)[9]
Red Drum
Reef Fish (43 species)
Shrimp (4 species)
Spiny Lobster[9]
Stone Crab
Highly Migratory Species - National Marine Fisheries Service Jurisdiction
Tunas (5 species)
Billfish (4 species)
Swordfish
Large Coastal Sharks (18 species)
Small Coastal Sharks (6 species)
Pelagic Sharks (10 species)

[1]Winter flounder is managed separately in state waters by the ASMFC
[2]Jointly managed by the NEFMC and ASMFC
[3]Jointly managed by the NEFMC (lead) and the MAFMC
[4]Jointly managed by the MAFMC (lead) and the NEFMC; managed separately in state waters through the ASMFC's coastal shark MU
[5]Jointly managed by the MAFMC and the ASMFC
[6]Summer flounder is jointly managed in the mid-Atlantic by the MAFMC and the ASMFC, and in New England waters as part of the NEFMC's Northeast Multispecies MU

[7]Black sea bass is jointly managed north of Cape Hatteras by the MAFMC and the ASMFC, and south of Cape Hatteras through the SAFMC's snapper-grouper complex MU
[8]Jointly managed by the GMFMC (lead) and the SAFMC; Spanish mackerel are managed separately in state waters by the ASMFC (Atlantic) and GSMFC (Gulf of Mexico)
[9]Jointly managed by the GMFMC (lead) and the SAFMC
[10]Jointly managed by the ASMFC (lead) and the SAFMC

The New England Fishery Management Council (NEFMC) manages nine fishery resources within the EEZ off the coasts of Maine, New Hampshire, Massachusetts, Rhode Island, and Connecticut. This geographic area includes the Boston Complex OPAREA and the northern portion of the Narragansett OPAREA. The Northeast Multispecies Fishery consists of 15 species of groundfish (demersal fish) that occupy similar habitats and that are harvested with similar methods. A subset of three (i.e., silver hake [whiting], red hake [ling], and offshore hake [blackeye whiting]) of these species requiring additional management measures comprises the small mesh multispecies fishery, which are managed primarily through a combination of mesh size restrictions and possession limits. The winter flounder fishery, which is part of the Northeast Multispecies MU, is managed in state waters by the ASMFC. The Atlantic herring MU is managed jointly with the ASMFC. The monkfish fishery is managed jointly with the Mid-Atlantic Fishery Management Council (MAFMC), with the NEFMC acting as the lead council. The Atlantic spiny dogfish fishery is managed jointly with the MAFMC, which is considered the lead council. Spiny dogfish are managed in state waters through the ASMFC'scoastal shark MU. EFH for Atlantic salmon consists primarily of freshwater streams, rivers, lakes, ponds, and wetlands, and as such is not applicable to this EIS/OEIS.

The MAFMC manages seven fishery resources (including shellfish species) in federal waters off the coasts of New York, New Jersey, Pennsylvania, Delaware, Maryland, Virginia, and North Carolina. (North Carolina is represented on both the Mid-Atlantic and South Atlantic Fishery Management Councils.) This geographic area includes part of the Narragansett OPAREA, the Atlantic City OPAREA, the VACAPES OPAREA, and most of the Cherry Point OPAREA. The Atlantic Mackerel, Squid, and Butterfish Management Unit includes two commercially important squid species (long-finned and short-finned). . The summer flounder fishery is managed jointly in the mid-Atlantic region with the MAFMC and the ASMFC, and in New England waters as part of the NEFMC's Northeast Multispecies MU. The black sea bass fishery is managed jointly north of Cape Hatteras by the MAFMC and the ASMFC, and south of Cape Hatteras through the South Atlantic Fishery Management Council's (SAFMC)s snapper-grouper complex MU.

The SAFMC manages eight fishery resources in federal waters off the coasts of North Carolina, South Carolina, Georgia, and the east coast of Florida to Key West. This geographic area includes part of the Cherry Point OPAREA, the Charleston OPAREA, the Jacksonville OPAREA, and part of the Key West OPAREA. Coastal Migratory Pelagic species are managed jointly with the Gulf of Mexico Fishery Management Council (GMFMC), which acts as the lead council. These species are considered a single management unit because their occurrence is influenced by similar temperature and salinity parameters. One coastal migratory pelagic species, Spanish mackerel, is managed separately in state waters by the ASMFC in the Atlantic Ocean and by the GSMFC in the Gulf of Mexico. The snapper-grouper complex includes 73 species of tropical and subtropical fish that are generally demersal in nature, occupy the same habitat types, and are harvested with similar methods. This complex includes numerous species of snappers, groupers, sea basses, porgies, grunts, tilefishes, triggerfishes, wrasses, and jacks. The shrimp fishery includes three species of panaeid shrimp (brown, pink, and white shrimp), royal red shrimp, and rock shrimp. The spiny lobster fishery is also managed jointly with the GMFMC. In addition to fish species, the SAFMC has prepared fishery management plans for important habitats including coral, coral reefs, live/hardbottom, and *Sargassum* seaweed. Coral, coral reefs, and live/hard bottom habitats are managed jointly by the SAFMC and the GMFMC, which acts as the lead council. The red drum fishery is managed jointly by the SAFMC and the ASMFC, which acts as the lead organization. The SAFMC generally divides EFH into inshore/estuarine and offshore categories. Inshore/estuarine EFH includes estuarine and palustrine marshes, shrub/scrub mangroves, seagrass, oyster reefs, shell banks, intertidal flats, aquatic beds, and the estuarine water column. Offshore habitats include live/hard bottom, coral and coral reefs, artificial/manmade reefs, *Sargassum*, and the marine water column.

The GMFMC manages seven fishery resources in federal waters off the coasts of Texas, Louisiana, Mississippi, Alabama, and the west coast of Florida to Key West. This geographic area includes part of the Key West OPAREA, the Pensacola/Panama City OPAREA, the New Orleans OPAREA, and the Corpus Christi OPAREA. The coral and coral reef FMP includes over 300 coral species. The reef fish FMP includes 43 species of snappers, groupers, sea bass, triggerfish, jacks, wrasses, sand perch, and tilefish. Fish in this FMP are generally demersal, subtropical species that utilize similar habitats and are harvested by similar methods, both recreationally and commercially. Shrimp species include brown, white, pink, and royal red. The spiny lobster fishery is managed jointly by the GMFMC and the SAFMC, with the GMFMC acting as the lead council. The Coastal Migratory Pelagics MU consists of king mackerel, Spanish mackerel, cobia, dolphin, little tunny, cero mackerel, and bluefish.

Highly Migratory Species (HMS) include several species of tunas, sharks, swordfish, and billfish. These species are generally associated with physiographic and hydrographic features such as ocean fronts, current boundaries, the continental shelf margin, or sea mounts. HMS may occur from the open ocean to nearshore waters. HMS in the Atlantic Ocean are managed by the Highly Migratory Species Division of the National Marine Fisheries Service.

EFH for the managed species and Management Units listed in Table 3-7 may be characterized with the general habitat categories described below. A complete description of EFH for each species and life stage may be obtained by contacting the appropriate fishery management council.

3.8.1.1 Benthic Habitat

These seafloor habitats, including the continental shelf and slope, consist of substrate such as rocks, gravel, cobble, pebbles, sand, clay, mud, silt, and shell fragments, as well as the water-sediment interface used by many invertebrates. These habitats are utilized by a variety of species for spawning/nesting, development, dispersal, and feeding.

3.8.1.1.1 Sediment Interface

This habitat, usually consisting of soft sediments, is generally composed of the areas from the seafloor to a depth of one meter below the water-sediment interface. This habitat is utilized primarily by juvenile and adult invertebrates.

3.8.1.1.2 Structured Habitats

These habitats include both human-made and biogenic structures that provide three-dimensional relief above the seafloor. They provide shelter and feeding opportunities for a variety of fish species, as well as surface area for settlement, attachment, and colonization by benthic organisms. Human-made structures include artificial reefs and shipwrecks. Artificial reefs represent physical enhancement of the seafloor by purposeful deposition of various types of materials. The structures are colonized by epibenthic plants and animals, and finfish such as reef-dwelling demersal species, planktivores, and piscivores. The value of the habitat generally increases over time. Juvenile and adult life stages of fishes use these structures for protection, orientation, and as feeding areas. Adult fishes may also use the habitat as a spawning site. Shipwrecks may be intentionally or unintentionally placed on the seafloor, and provide habitat functions similar to that of artificial reefs.

Biogenic structured habitats are created by living organisms such as sponges, mussels, hydroids, amphipods, algae, bryozoans, and corals. The principal biogenic habitats include corals, coral reefs, and hard/live bottom. Coral reef communities or solitary specimens occur throughout the south Atlantic region from nearshore environments to continental slopes and canyons, including the intermediate shelf zones. Dependent upon many variables, corals may dominate a habitat, be a significant component, or be individuals within a community characterized by other fauna. The coral reefs of shallow warm waters are typically, though not always, built upon coralline rock and support a wide array of hermatypic and ahermatypic corals, finfish, invertebrates, plants, and microorganisms. Hard/live bottoms and hard banks, found on a wider bathymetric and geographic scale, consist of naturally-occurring hard or rocky outcroppings. These outcroppings often possess high species diversity (vertebrate, invertebrate, and algal growth) but may lack hermatypic corals, the supporting coralline structure, or some of the associated biota. In deeper waters, large elongate mounds called deepwater banks, hundreds of meters in length, often support a rich fauna compared to adjacent areas. Lastly are communities including solitary corals. This habitat type often lacks a topographic relief as its substrate, but instead may use a sandy bottom. In order of increasing species diversity, coral habitats (i.e., habitats to which coral is a significant contributor) progress from solitary corals, hard bottoms, deepwater banks, patch reefs, to outer bank reefs.

In addition to shallow-water corals and reef systems, deepwater corals (*Oculina varicosa* and *Lophelia pertusa*) also provide habitat for many species. In the AFAST Study Area, *Oculina* coral occurs along the Atlantic continental shelf, with concentrations off the east–central coast of Florida (SAFMC, 2008). A notable area of *Oculina* occurrence is the Oculina Bank off central Florida, where this coral grows on limestone pinnacles that extend tens of meters above the surrounding seafloor. *Lophelia* is more widely distributed, but the extent of distribution has not been extensively studied. *Lophelia* is known to occur on the Blake Plateau in the Atlantic and at areas in the GOMEX.

3.8.1.2 Pelagic *Sargassum*

Mats of the pelagic brown algae *Sargassum* (*Sargassum natans* and *S. fluitans*) provide an important habitat for numerous fishes, especially the larval and juvenile life stages. These mats form a dynamic structural habitat on the sea surface that provides shelter, food, and spawning substrate. Juvenile fish are the dominant vertebrate inhabitants of *Sargassum* rafts; however, adult fish and large predators forage under and around *Sargassum* rafts. Over 100 species of fish have been collected or observed in association with *Sargassum* habitats, including reef, coastal demersal, coastal pelagic, epipelagic, and mesopelagic species. In the North Atlantic Ocean, *Sargassum* occurs primarily within the North Atlantic Gyre between 20°N and 40°N and between 30°W and the western edge of the Gulf Stream (Dooley, 1972; SAFMC, 2002a). However, the areal extent and abundance of *Sargassum* at any given location is unpredictable and depends primarily upon prevailing surface currents. Pelagic *Sargassum* could occur from the shoreline to the seaward boundary of the Study Area.

3.8.1.3 Gulf Stream Current

The Gulf Stream is the dominant surface water mass in the South Atlantic Bight and flows roughly parallel to the coastline from the Florida Straits to Cape Hatteras, North Carolina, where it is deflected and flows northeastward. The Gulf Stream provides a dispersal mechanism for the larvae of many species, and functions as a diverse and productive pelagic habitat.

3.8.1.4 Marine Water Column

This habitat includes the vertical column of water from the surface to the ocean floor. Depending on the species, designated habitat may only refer to part of the water column such as the surface or bottom waters. Specific habitats in the water column can best be defined in terms of gradients and discontinuities in temperature, salinity, density, nutrients, light, etc. These "structural" components of the water column environment are not static, but change both in time and space. Therefore, there are numerous potentially distinct water column habitats for a wide variety of managed species and their life stages.

3.8.1.5 Estuarine and Intertidal Habitats

These habitats occur near the shoreline and consist of estuarine emergent vegetation (salt marsh and brackish marsh), estuarine shrub/scrub (mangroves), submerged aquatic vegetation (although this habitat type can occur to water depths up to 46 m [150 ft], oyster reefs and shell banks, intertidal flats, aquatic beds, palustrine emergent and forested wetlands, and the estuarine water column (SAFMC, 1998).

3.8.1.6 Habitat Areas of Particular Concern

Designation of Habitat Areas of Particular Concern may vary, depending on the particular Fisheries Management Council. Some Councils specify individual or specific habitats while others designate broad geographic areas. Some Councils designate HAPC for all managed species, while others designate HAPC for particular species or life stages. Table 3-8 lists the HAPC currently designated for all species and Management Units within the AFAST Study Area. The SAFMC has proposed four additional deepwater coral areas as HAPCs (in addition to the Oculina Bank HAPC). These areas will be established through the Comprehensive Fishery Ecosystem Plan Amendment currently in preparation. The additional HAPCs will have a broad distribution, ranging from North Carolina to southern Florida.

Table 3-8. Habitat Areas of Particular Concern in the AFAST Study Area

EFH Species	HAPC Description	Designations
Atlantic Cod	Gravel and cobble substrate along the northern edge of Georges Bank.	Juveniles
Sandbar shark	Shallow areas at the mouth of Great Bay, New Jersey; lower and middle Delaware Bay; lower Chesapeake Bay; near the Outer Banks, North Carolina, in areas of Pamlico Sound adjacent to Hatteras and Ocracoke Islands to just offshore of these barrier islands.	All life stages
Summer flounder	All native species of macroalgae, seagrass, and freshwater and tidal macrophytes in any size bed, as well as loose aggregations, within designated EFH.	Juveniles and adults
Atlantic salmon	Eleven rivers in Maine.	All life stages
Snapper-Grouper Complex	Medium-high profile offshore and nearshore hard bottom, *Sargassum*, hermatypic coral habitats and reefs; manganese outcroppings on Blake Plateau; artificial reef Special Management Zones; The Point (North Carolina); Ten Fathom Ledge (North Carolina); Big Rock (North Carolina); Charleston Bump (South Carolina); Hoyt Hills; *Oculina* Bank; seagrass, mangrove, and oyster/shell habitat; coastal inlets and state-designated nursery habitats.	All life stages
Coastal Migratory Pelagic Management Unit	Sandy shoals associated with Cape Lookout, Cape Fear, and Cape Hatteras, North Carolina, from shore to the limit of the respective shoals, but shoreward of the Gulf Stream; The Point (North Carolina); *Sargassum*; Ten Fathom Ledge (North Carolina); Big Rock (North Carolina); Charleston Bump (South Carolina); Hurl Rocks (South Carolina); the Point off Jupiter Inlet, Florida; *Phragmatopoma* reefs (central east coast of Florida); nearshore hard bottom south of Cape Canaveral, Florida; the Hump off Islamorada, Florida; Marathon Hump (Florida); the Wall off the Florida Keys.	All life stages
Dolphinfish and wahoo	The Point (North Carolina); Ten Fathom Ledge (North Carolina); Big Rock (North Carolina); Charleston Bump (South Carolina); Georgetown Hole (South Carolina); Amberjack Lump (Florida); the Hump off Islamorada, Florida; Marathon Hump, Florida; the Wall off the Florida Keys; the Gulf Stream and associated eddies within the EEZ.	All life stages
Red drum	Costal inlets; state-designated nursery habitats; documented spawning aggregation sites; barrier islands and their inlets; submerged aquatic vegetation in Virginia, North Carolina, and Florida; the entire estuarine systems of South Carolina and Georgia; inlets, adjoining channels, sounds, and outer bars of ocean inlets.	All life stages
Panaeid Shrimp Management Unit	Coastal inlets, state-designated nursery areas, and state-identified overwintering areas.	All life stages
Spiny lobster	Florida bay, Biscayne Bay, card Sound, and coral/hard bottom habitat from Jupiter Inlet, Florida through the Dry Tortugas, Florida.	All life stages

Table 3 8. Habitat Areas of Particular Concern in the AFAST Study Area, Cont'd

EFH Species	HAPC Description	Designations
Coral, coral reefs, and live/hardbottom habitat	Ten Fathom Ledge (North Carolina); Big Rock (North Carolina); The Point (North Carolina); Hurl Rock (South Carolina); Charleston Bump (South Carolina); Gray's Reef National Marine Sanctuary (Georgia); shallow hard bottom from Palm beach County, Florida to Fowey Rocks, Florida, and the Florida Keys National Marine Sanctuary; *Oculina* bank; *Phragmatopoma* reefs (central east coast of Florida); nearshore hard bottom from Cape Canaveral, Florida to Broward County, Florida; Biscayne Bay, Florida; Biscayne National Park, Florida.	All corals
All species with EFH designations	Florida Middle Grounds, Tortugas North and South, Madison-Swanson Marine Reserve, Pulley Ridge (Florida); West and East Flower garden Banks, Stetson Bank, 29 Fathom Bank, MacNeil Bank, Rezak Snider Bank, Rankin Bright Bank, Geyer bank, McGrail Bank, Bouma bank, Sonnier Bank, Alderice Bank, Jakkula Bank (Texas).	All life stages

3.8.2 Cooperative Habitat Protection Program

NOAA's Habitat Protection Division is in the process of developing a proposal that will establish a Cooperative Habitat Protection Program. This purpose of this program would be to work with local communities, government entities, and grassroots nongovernmental organizations to protect nearshore fish habitats. The draft proposal focuses on local partnerships, watershed planning, communication, and technical assistance or small grants to "equip local communities with the tools and information needed to protect coastal and marine fish habitat" (NOAA, 2007h).

3.9 MARINE FISH

The Magnuson-Stevens Act establishes management authority over all fishing within the U.S. EEZ, all anadromous fish throughout their migratory range, and all fish on the continental shelf.

Fish species in the AFAST Study Area are managed or co-managed by the following entities:

- ASMFC; jurisdiction is state waters from Maine through eastern Florida.
- GSMFC; jurisdiction is state waters from western Florida through Texas
- NEFMC; jurisdiction is federal waters from Maine to Connecticut.
- MAFMC; jurisdiction is federal waters from New York to North Carolina.
- SAFMC; jurisdiction is federal waters from North Carolina to eastern Florida at Key West.
- GMFMC; jurisdiction is federal waters from western Florida to Texas.
- NMFS; jurisdiction over highly migratory species in federal waters off the U.S. Atlantic coast and the GOMEX.

In addition, these entities may designate EFH outside of their region of jurisdiction.

3.9.1 Threatened/Endangered and Species of Concern Marine Fish

There are a number of fish in the AFAST Study Area that, for various reasons, are listed as threatened and endangered species list. Overfishing is generally the primary cause of fish becoming listed as threatened/endangered species (Table 3-9). Overfishing occurs when targeted or nontargeted fish are pulled up by catch. Other causes for reduction in species numbers can be due to changes in habitat conditions, direct and indirect construction and dredging, runoff of polluted water and materials, and some oil and gas exploration activities. It is critical that the following lists are reviewed for relevance to each OPAREA.

Table 3-9. Fish Species/Threatened or Endangered

Endangered/Threatened Species Report		
Inverted Common Name	**Scientific Name**	**Listing Status**
Atlantic salmon	*Salmo salar*	E
Smalltooth sawfish	*Pristis pectinata*	E
Gulf sturgeon	*Acipenser oxyrinchus desotoi*	T
Shortnose sturgeon	*Acipenser brevirostrum*	E

E - endangered; T – threatened

3.9.2 Description of Marine Fish Acoustics

Marine fish occupy an important part of the marine food chain, and serve as prey for many other species including humans, marine mammals (cetaceans and pinnipeds), seabirds, and other marine species including other fish. Seabirds eat small marine fish, squid, shellfish, and a variety of crustaceans. Cetaceans include dolphins and toothed whales (odontocetes) and baleen whales (mysticetes). Odontocetes and pinnipeds are primarily carnivores, while baleen whales have evolved special filter-like structures to gather small shrimp, small fish, squid, and plankton. Some cetaceans actively hunt prey, either alone or in cooperative groups, primarily eating whatever fish are found in the oceanic zone that they inhabit. Many marine mammals also eat squid, octopus, shrimp, and crabs.

Most marine fish spend part of their lives in saltwater and part of their lives in freshwater. Different life cycles for marine fish include the following:

- Estuarine-dependant fish depend on bays and/or estuaries for part of their life cycle.
- Catadromous fish spawn in saltwater, then migrate into freshwater to grow to maturity.
- Anadromous fish are born in fresh water, migrate to the ocean to grow into adults, and return to fresh water to spawn (FWS, 2007).
- Some fish are totally marine species and spend their entire lives at sea.

3.9.2.1 Hearing in Marine Fish

Hearing capability data exist only for fewer than 100 of the 29,000 known fish species (Hastings and Popper, 2008), and therefore caution must be exercised in extending the results of limited studies to fish in general. Data collected to date suggests that most fish hear in the frequency range of 0.05 to 1.0 kHz, with few fish hearing sounds above 4 kHz (Popper, 2008; NRC, 2003).

Most marine fish, which are defined as fish that spend at least part of their life in salt water, have best hearing sensitivity at or below 0.3 kHz (Popper, 2003). All fish have two sensory systems that are used to detect sound in the water including the inner ear, which functions very much like the inner ear found in other vertebrates, and the lateral line, which consists of a series of receptors along the body of the fish (Popper, 2008). The inner ear generally detects higher frequency sounds while the lateral line detects water motion at low frequencies (below a few hundred Hz) (Hastings and Popper, 2005). A sound source produces both a pressure wave and motion of the medium particles (water molecules in the case of underwater sound), both of which may be important to fish. Fish detect particle motion with the inner ear. Pressure signals are initially detected by the gas-filled swim bladder or other air pockets in the body, which then re-radiate the signal to the inner ear (Popper, 2008). Because particle motion attenuates relatively quickly, the pressure component of sound usually dominates as distance from the source increases. The lateral line, discussed in more detail at the end of this section, is sensitive to low-frequency water movement. Broadly, fishes can be categorized as either hearing specialists or hearing generalists (Popper, 2008). Fishes in the hearing specialist category have a broad frequency range with a low auditory threshold due to a mechanical connection between an air filled cavity, such as a swimbladder, and the inner ear. Specialists detect both the particle motion and pressure components of sound and can hear at levels above 1 kHz. Generalists are limited to detection of the particle motion component of low frequency sounds at relatively high sound intensities (Amoser and Ladich, 2005). It is possible that a species will exhibit characteristics of generalists and specialists and will sometimes be referred to as an "intermediate" hearing specialist. For example, most damselfish are typically categorized as generalists, but because some larger damselfish have demonstrated the ability to hear higher frequencies expected of specialists, they are sometimes categorized as intermediate.

Studies indicate that hearing specializations in marine species are rare and that most marine fish are considered hearing generalists (Popper, 2003; Amoser and Ladich, 2005). Specifically, the following species are all believed to be hearing generalists: elasmobranchs (i.e., sharks and rays) (Casper et al., 2003; Casper and Mann, 2006; Myrberg, 2001), scorpaeniforms (i.e., scorpionfishes, searobins, sculpins) (Lovell et al., 2005), scombrids (i.e., albacores, bonitos, mackerels, tunas) (Iversen, 1967; Iversen, 1969; Popper, 1981; Song et al., 2006), damselfishes (Egner and Mann, 2005; Kenyon, 1996; Wright et al., 2005; Wright et al., 2007), and more specifically, midshipman fish (*Porichthys notatus*) (Sisneros and Bass, 2003), Atlantic salmon (*Salmo salar*) (Hawkins and Johnstone, 1978), and Gulf toadfish (*Opsanus beta*) (Remage-Healey et al., 2006). Moreover, it is believed that the majority of marine fish have their best hearing sensitivity at or below 0.3 kHz (Popper, 2003). However, it has been demonstrated that some marine hearing specialists can detect sounds up to 4 kHz, and a few can detect sounds above 120 kHz (although gaps in hearing sensitivity may exist in these species) (Dunning et al., 1992; Mann et al., 1998; Mann et al., 2001; Nestler et al., 2002; Popper and Carlson, 1998; Ross et al., 1996). For example, some Clupeidae can detect sounds above 100 kHz. Refer to Table 3-10 for a list of marine fish hearing sensitivities.

Table 3-10. Marine Fish Hearing Sensitivities

Family	Description of Family	Common Name	Scientific Name	Hearing Range (kHz)		Greatest Sensitivity (kHz)	Sensitivity Classification
				Low	High		
Albulidae	Bonefishes	Bonefish	*Albula vulpes*	0.1	0.7	0.3	generalist
Anguillidae	Eels	European eel	*Anguilla anguilla*	0.01	0.3	0.04-0.1	generalist
Ariidae	Catfish	Hardhead sea catfish	*Ariopsis* (*Arius*) *felis**	0.05	1	0.1	generalist
Batrachoididae	Toadfishes	Midshipman	*Porichthys notatus*	.065	0.385		generalist
		Gulf toadfish	*Opsanus beta*			<1	generalist
Clupeidae	Herrings, shads, menhadens, sardines	Alewife	*Alosa psuedoharengus*		0.12		specialist
		Blueback herring	*Alosa aestivalis*		0.12		specialist
		American shad	*Alosa sapidissima*	0.1	0.18	0.2-0.8 and 0.025-0.15	specialist
		Gulf menhaden	*Brevoortia patronus*		0.1		specialist
		Bay anchovy	*Anchoa mitchilli*		4		specialist
		Scaled sardine	*Harengula jaguana*		4		specialist
		Spanish sardine	*Sardinella aurita*		4		specialist
		Pacific herring	*Clupea pallasii*	0.1	5		specialist
Chondrichthyes [Class]	Cartilaginous fishes, rays, sharks, skates			0.2	1		generalist
Gadidae	Cods, gadiforms, grenadiers, hakes	Cod	*Gadus morhua*	0.002	0.5	0.02	generalist
Gobidae	Gobies	Black goby	*Gobius niger*	0.1	0.8		generalist
Holocentridae	Squirrelfish and soldierfish	Shoulderbar soldierfish	*Myripristis kuntee*	0.1	3.0	0.4-0.5	specialist
		Hawaiian squirrelfish	*Adioryx xantherythrus*	0.1	0.8		generalist
Labridae	Wrasses	Tautog	*Tautoga onitis*	0.01	0.5	0.037-0.050	generalist
		Blue-head wrasse	*Thalassoma bifasciatum*	0.1	1.3	0.3-0.6	generalist
Lutjanidae	Snappers	Schoolmaster snapper	*Lutjanus apodus*	0.1	1.0	0.3	generalist
Myctophidae	Lanternfishes	Warming's lanternfish	*Ceratoscopelus warmingii*				specialist

Table 3-10. Marine Fish Hearing Sensitivities Cont'd

Family	Description of Family	Common Name	Scientific Name	Hearing Range (kHz)		Greatest Sensitivity (kHz)	Sensitivity Classification
Pleuronectidae	Flatfish	Dab	*Limanda limanda*	0.03	0.27	0.1	generalist
		European plaice	*Pleuronectes platessa*	0.03	0.2	0.11	Generalist
Pomadasyidae	Grunts	Blue striped grunts	*Haemulon sciurus*	0.1	1.0		generalist
Pomacentridae	Damselfish	Sergeant major damselfish	*Abudefduf saxatilis*	0.1	1.6	0.1-0.4	Generalist/ intermediate
		Bicolor damselfish	*Stegastes partitus*	0.1	1.0	0.5	Generalist/ intermediate
		Nagasaki damselfish	*Pomacentrus nagasakiensis*	0.1	2.0	<0.3	Generalist/ intermediate
Salmonidae	Salmons	Atlantic salmon	*Salmo salar*	<0.1	0.58		generalist
Sciaenidae	Drums, weakfish, croakers	Atlantic croaker	*Micropogonias undulatus*	0.1	1.0	0.3	generalist
		Spotted sea trout	*Cynoscion nebulosus*				generalist
		Kingfish	*Menticirrhus americanus*				generalist
		Spot	*Leiostomus xanthurus*	0.2	0.7	0.4	generalist
		Black drum	*Pogonias cromis*	0.1	0.8	0.1-0.5	generalist
		Weakfish	*Cynoscion regalis*	0.2	2.0	0.5	specialist
		Silver perch	*Bairdiella chrysoura*	0.1	4.0	0.6-0.8	specialist
Scombridae	Albacores, bonitos, mackerels, tunas	Bluefin tuna	*Thunnus thynnus*		1.0		generalist
		Yellowfin tuna	*Thunnus albacares*	0.5	1.1		Generalist
		Kawakawa	*Euthynnus affinis*	0.1	1.1	0.5	generalist
		Skipjack tuna	*Katsuwonus pelamis*				generalist
Scorpaenidae	Scorpionfishes, searobins, sculpins	Sea scorpion	*Taurulus bubalis*				generalist
Serranidae	Seabasses, groupers	Red hind	*Epinephelus guttatus*	0.1	1.1	0.2	generalist
Sparidae	Porgies	Pinfish	*Lagodon rhomboides*	0.1	1.0	0.3	generalist
Triglidae	Scorpionfish, searobins, sculpins	Leopard searobin	*Prionotus scitulus*	0.1	0.8	0.39	generalist

* Referenced as *Arius felis* by Popper and Tavolga, 1981.

Sources: Astrup, 1999; Astrup and Mohl, 1993; Casper and Mann, 2006; Casper et al., 2003; Coombs and Popper, 1979; Dunning et al., 1992; Egner and Mann, 2005; Gregory and Clabburn, 2003; Hawkins and Johnstone, 1978; Higgs et al., 2004;

Table 3-10. Marine Fish Hearing Sensitivities Cont'd

Iversen, 1967, 1969; Jorgensen et al., 2004; Kenyon, 1996; Lovell et al., 2005; Mann et al., 1997, 2001, 2005; Myrberg, 2001; Nestler et al., 2002; Popper, 1981; Popper and Carlson, 1998; Popper and Tavolga, 1981; Ramcharitar and Popper, 2004; Ramcharitar et al., 2001, 2004, 2006, Remage-Healey, et al., 2006; Ross et al., 1996; Sisneros and Bass, 2003; Song et al., 2006; Wright et al., 2005, 2007; Seaworld, 2007; Popper, 2008

In contrast to marine fish, several thousand freshwater species are thought to be hearing specialists. Nelson (1994) estimates that 6,600 of 10,000 freshwater species are otophysans (catfish and minnows), which are hearing specialists. Interestingly, many generalist freshwater species, such as perciforms (percids, gobiids) and scorpaeniforms (sculpins) are thought to have derived from marine habitats (Amoser and Ladich, 2005). It is also thought that Clupeidae may have evolved from freshwater habitats (Popper et al., 2004). This supports the theory that hearing specializations likely evolved in quiet habitats common to freshwater and the deep sea because only in such habitats can hearing specialists use their excellent hearing abilities (Amoser and Ladich, 2005).

In contrast to marine fish, several thousand freshwater species are thought to be hearing specialists. Nelson (1994) estimates that 6,600 of 10,000 freshwater species are otophysans (catfish and minnows), which are hearing specialists. Interestingly, many generalist freshwater species, such as perciforms (percids, gobiids) and scorpaeniforms (sculpins) are thought to have derived from marine habitats (Amoser and Ladich, 2005). It is also thought that Clupeidae may have evolved from freshwater habitats (Popper et al., 2004). This supports the theory that hearing specializations likely evolved in quiet habitats common to freshwater and the deep sea because only in such habitats can hearing specialists use their excellent hearing abilities (Amoser and Ladich, 2005).

Some investigators (e.g., Amoser and Ladich, 2005) hypothesized that, within a family of fish, different species can live under different ambient noise conditions, which requires them to adapt their hearing abilities. Under this scenario, a species' probability of survival would be greater if it increased, the range over which the acoustic environment, consisting of various biotic (sounds from other aquatic animals) and abiotic (wind, waves, precipitation) sources, can be detected (Amoser and Ladich, 2005). In the marine environment, Amoser and Ladich (2005) cite the differences in the hearing ability of two species of Holocentridae as a possible example of such environmentally-derived specialization. Both the shoulderbar soldierfish (*Myripristis kuntee*) and the Hawaiian squirrelfish (*Adioryx xantherythrus*) can detect sounds at 0.1 kHz. However, the high frequency end of the auditory range extends towards 3 kHz for the shoulderbar soldierfish but only to 0.8 kHz for the Hawaiian squirrelfish (Coombs and Popper, 1979).

However, as these two species live in close proximity on the same reefs, it is not certain that differing environmental conditions cause the hearing variations (Popper, 2008). Generally, a clear correlation between hearing capability and the environment cannot be asserted or refuted due to limited knowledge of ambient noise levels in marine habitats and a lack of comparative studies.

It has also been shown that susceptibility to the effects of anthropogenic sound can be influenced by developmental and genetic differences in the same species of fish. In an exposure experiment, Popper et al. (2007) found that experimental groups of rainbow trout (*Oncorhynchus mykiss*) had substantial differences in hearing thresholds. While fish were attained from the same supplier, it is possible different husbandry techniques may be reason for the differences in hearing sensitivity. These results emphasize that caution should be used in extrapolating data beyond their intent.

Among all fishes studied to date, perhaps the greatest variability is found within the family Sciaenidae (i.e., drumfish, weakfish, croaker), where there is extensive diversity in inner ear structure and the relationship between the swim bladder and the inner ear. Specifically, the Atlantic croaker's (*Micropogonias undulatus*) swim bladder has forwardly directed diverticulae that come near the ear but do not actually touch it. However, the swim bladders in the spot (*Leiostomus xanthurus*) and black drum (*Pogonias cromis*) are further from the ear and lack anterior horns or diverticulae. These differences are associated with variation in both sound production and hearing capabilities (Ladich and Popper, 2004; Ramcharitar et al., 2006b). Ramcharitar and Popper (2004) discovered that the black drum responded to sounds from 0.1 to 0.8 kHz and was most sensitive between 0.1 and 0.5 kHz, while the Atlantic croaker responded to sounds from 0.1 to 1 kHz and was most sensitive at 0.3 kHz. Additional sciaenid research by Ramcharitar et al. (2006) investigated the hearing sensitivity of weakfish (*Cynoscion regalis*) and spot. Weakfish were found to detect frequencies up to 2 kHz, while spot detected frequencies only up to 0.7 kHz.

The sciaenid with the greatest hearing sensitivity discovered thus far is the silver perch (*Bairdiella chrysoura*), which has demonstrated auditory thresholds similar to goldfish, responding to sounds up to 4 kHz (Ramcharitar et al., 2004). Silver perch swim bladders have anterior horns that terminate close to the ear. The Ramcharitar et al. (2004) research supports the suggestion that the swim bladder can potentially expand the frequency range of sound detection. Furthermore, Sprague and Luczkovich (2004) calculated silver perch are capable of producing drumming sounds ranging from 128 to 135 dB. Since drumming sounds are produced by males during courtship, it can be inferred that silver perch detect sounds within this range.

The most widely noted hearing specialists are otophysans, which have bony Weberian ossicles, (bones that connect the swim bladder to the ear), along which vibrations are transmitted from the swim bladder to the inner ear (Amoser and Ladich, 2003; Ladich and Wysocki, 2003). However, only a few otophysans inhabit marine waters. In an investigation of a marine otophysan, the hardhead sea catfish (*Ariopsis felis*), Popper and Tavolga (1981) determined that this species was able to detect sounds from 0.05 to 1 kHz, which is considered a much lower and narrower frequency range than that common to freshwater otophysans (i.e., above 3 kHz) (Ladich and Bass, 2003). The difference in hearing capabilities in the respective freshwater and marine catfish appears to be related to the inner ear structure (Popper and Tavolga, 1981).

Experiments on marine fish have obtained responses to frequencies up to the range of ultrasound; that is, sounds between 40 to 180 kHz (University of South Florida, 2007). These responses were from several species of the Clupeidae (i.e., herrings, shads, and menhadens) (Astrup, 1999); however, not all clupeid species tested have responded to ultrasound. Astrup (1999) and Mann et al. (1998) hypothesized that these ultrasound detecting species may have developed such high sensitivities to avoid predation by odontocetes. Studies conducted on the following species showed avoidance to sound at frequencies over 100 kHz: alewife (*Alosa pseudoharengus*) (Dunning et al., 1992; Ross et al., 1996), blueback herring (*A. aestivalis*) (Nestler et al., 2002), Gulf menhaden (*Brevoortia patronus*) (Mann et al., 2001) and American shad (*A. sapidissima*) (Popper and Carlson, 1998). The highest frequency to solicit a response in any marine fish was 180 kHz for the American shad (Gregory and Clabburn, 2003; Higgs et al., 2004). The *Alosa* species have relatively low thresholds (about 145 dB re 1 µPa), which should enable the fish to detect odontocete clicks at distances up to about 200 m (656 ft) (Mann et al., 1997). For example, echolocation clicks ranging from 200 to 220 dB could be detected by shad with a hearing threshold of 170 dB at distances from 25 to 180 m (82 to 591 ft) (University of South Florida, 2007). In contrast, the Clupeidae bay anchovy (*Anchoa mitchilli*), scaled sardine (*Harengula jaguana*), and Spanish sardine (*Sardinella aurita*) did not respond to frequencies over 4 kHz (Gregory and Clabburn, 2003; Mann et al., 2001).

Wilson and Dill (2002) demonstrated that there was a behavioral response seen in Pacific herring (*Clupea pallasii*) to energy levels associated with frequencies from 1.3 to 140 kHz, although it was not clear whether the herring were responding to the lower-frequency components of the experiment or to the ultrasound. However, Mann et al. (2005) advised that acoustic signals used in the Wilson and Dill (2002) study were broadband and contained energy of less than 4 kHz to ultrasonic frequencies. Contrary to the Wilson and Dill (2002) conclusions, Mann et al. (2005) found that Pacific herring could not detect ultrasonic signals at received levels up to 185 dB re 1 µPa. Pacific herring had hearing thresholds (0.1 to 5 kHz) that are typical of Clupeidae that do not detect ultrasound signals.

Species that can detect ultrasound do not perceive sound equally well at all detectable frequencies. Mann et al. (1998) reported that the American shad can detect sounds from 0.1 to 180 kHz with two regions of best sensitivity: one from 0.2 to 0.8 kHz, and the other from 25 to 150 kHz. The poorest sensitivity was found from 3.2 to 12.5 kHz.

Although few non-clupeid species have been tested for ultrasound (Mann et al., 2001), the only other non-clupeid species shown to possibly be able to detect ultrasound is the cod (*Gadus morhua*) (Astrup and Mohl, 1993). However, in Astrup and Moh's (1993) study it is feasible that the cod was detecting the stimulus using touch receptors that were over driven by very intense fish-finding sonar emissions (Astrup, 1999; Ladich and Popper, 2004). Nevertheless, Astrup and Mohl (1993) indicated that cod have ultrasound thresholds of up to 38 kHz at 185 to 200 dB re 1 µPa, which likely only allows for detection of odontocete's clicks at distances no greater than 10 to 30 m (33 to 98 ft) (Astrup, 1999).

As mentioned above, investigations into the hearing ability of marine fishes have most often yielded results exhibiting poor hearing sensitivity. Experiments on elasmobranch fish (i.e., sharks and rays) have demonstrated poor hearing abilities and frequency sensitivity from 0.02 to 1 kHz, with best sensitivity at lower ranges (Casper et al., 2003; Casper and Mann, 2006; Myrberg, 2001). Though only five elasmobranch species have been tested for hearing thresholds, it is believed that all elasmobranchs will only detect low-frequency sounds because they lack a swim bladder, which resonates sound to the inner ear. Theoretically, fishes without an air-filled cavity, such as the ESA-listed smalltooth sawfish, are limited to detecting particle motion and not pressure and therefore have poor hearing abilities (Casper and Mann, 2006). Although other ESA-listed species within the AFAST Study Area have swim bladders, the association between this organ and the inner ear may influence hearing ability. The hearing capability of Atlantic salmon indicates a rather low sensitivity to sound (Hawkins and Johnstone, 1978), which is likely due to to the lack of a link between the swim bladder and inner ear (Jorgensen et al., 2004). Laboratory experiments yielded responses only to 0.58 kHz and only at high sound levels.

By examining the morphology of the inner ear of bluefin tuna (*Thunnus thynnus*), Song et al. (2006) hypothesized that bluefin tuna probably do not detect sounds to much over 1 kHz (if that high). This research concurred with the few other studies conducted on tuna species. Iversen (1967) found that yellowfin tuna (*T. albacares*) can detect sounds from 0.05 to 1.1 kHz, with best sensitivity of 89 dB (re 1 µPa) at 0.5 kHz. Kawakawa (*Euthynnus affinus*) appear to be able to detect sounds from 0.1 to 1.1 kHz but with best sensitivity of 107 dB (re 1 µPa) at 0.5 kHz (Iversen, 1969). Additionally, Popper (1981) looked at the inner ear structure of a skipjack tuna (*Katsuwonus pelamis*) and found it to be typical of a hearing generalist. While only a few species of tuna have been studied, and in a number of fish groups both generalists and specialists exist, it is reasonable to suggest that unless bluefin tuna are exposed to very high intensity sounds from which they cannot swim away, short- and long-term effects may be minimal or nonexistent (Song et al., 2006).

Some damselfish have been shown to be able to hear frequencies of up to 2 kHz, with best sensitivity well below 1 kHz. Egner and Mann (2005) found that juvenile sergeant major damselfish (*Abudefduf saxatilis*) were most sensitive to lower frequencies (0.1 to 0.4 kHz); however, larger fish (greater than 50 millimeters) responded to sounds up to 1.6 kHz. Still, the sergeant major damselfish is considered to have poor sensitivity in comparison even to other hearing generalists (Egner and Mann, 2005). Kenyon (1996) studied another marine generalist, the bicolor damselfish (*Stegastes partitus*), and found the bicolor damselfish responded to sounds up to 1.6 kHz with the most sensitive frequency at 0.5 kHz. Further, larval and juvenile Nagasaki damselfish (*Pomacentrus nagasakiensis*) have been found to hear at frequencies between 0.1 and 2 kHz, however, they are most sensitive to frequencies less than 0.3 kHz (Wright et al., 2005; Wright et al., 2007). Thus, damselfish appear to be primarily generalists with some ability to hear slightly higher frequencies expected of specialists (Popper, 2008).

Female midshipman fish apparently use the auditory sense to detect and locate vocalizing males during the breeding season. Interestingly, female midshipman fish go through a shift in hearing sensitivity depending on their reproductive status. Reproductive females showed temporal encoding up to 0.34 kHz, while nonreproductive females showed comparable encoding only up to 0.1 kHz (Sisneros and Bass, 2003).

Furthermore, investigations into the inner ear structure of fishes belonging to the order Scorpaeniformes have suggested that these fishes have generalist hearing abilities (Lovell et al., 2005). Although an audiogram (which provides a measure of hearing sensitivity) has yet to be performed, the lack of a swimbladder is indicative of these species having poor hearing ability (Lovell et al., 2005). However, studies of the leopard robin (*Prionotus scitulus*), another species in this order that do contain swim bladders, indicated that they are hearing generalists as well

(Tavolga and Wodinski, 1963) which makes extrapolation on hearing from this species to all members of the group very difficult to do (Popper, 2008).

As mentioned above, the lateral line is the second component of the sensory system used by fish to detect acoustic signals. The lateral line system of a fish allows for sensitivity to sound (Hastings and Popper, 2005). This system is a series of receptors along the body of the fish that detects water motion relative to the fish that arise from sources within a few body lengths of the animal. The sensitivity of the lateral line system is generally from below 1 Hz to a few hundred Hertz (Coombs and Montgomery, 1999; Webb et al., 2008). The only study on the effect of exposure to sound on the lateral line system (conducted on one freshwater species) suggests no effect on these sensory cells by intense pure tone signals (Hastings et al., 1996). While studies on the effect of sound on the lateral line are limited, Hasting et al.'s (1996) work, showing limited sensitivity to within a few body lengths and to sounds below a few hundred Hertz make the effect of the mid-frequency sonar of the Proposed Action unlikely to affect a fish's lateral line system. Therefore, further discussion of the lateral line in this analysis in unwarranted.

Of the fish species with distributions overlapping the AFAST Study Area for which hearing sensitivities are known, most are hearing generalists.

3.9.2.1.1 Tonal Sound (Sonar)

Few peer-reviewed studies have been published regarding the ability of fish to hear human-generated tonal sounds (Popper, 2008). However, existing reports do provide some insight into the detection of these sounds and possible effects to fish. The range of potential effects includes no effect, behavioral effects, temporary loss of hearing, physical damage to auditory and non-auditory tissues, and mortality (Popper, 2008). For instance, studies have shown that hearing generalists normally experience only minor or no hearing loss when exposed to continuous sound, while hearing specialists may experience significant threshold shifts (Scholik and Yan, 2001; Smith et al., 2004a; Smith et al., 2004b).

Popper et al. (2007) studied the effects of SURTASS LFA sonar on hearing, ear structure, and non-auditory systems in rainbow trout (*Onchorhynchus mykiss*). The fish were exposed to maximum received levels of 193 dB re 1 μPa at 196 Hz for a duration of approximately 5 to 10 minutes (a duration much greater than would likely occur in the wild due to Navy operations). No mortality was reported. One experimental group of trout showed evidence of hearing loss, the most significant of which was a hearing threshold shift of approximately 20 dB at 400 Hz. However, the exposure had little effect on the hearing of a second experimental group. The reason(s) for the different results were not known, but may be due to developmental or genetic effects. Hearing loss was evident in some fish up to 48 hours after exposure, after which time the investigation was concluded. No effects to body tissues, swim bladders, or ear tissues were found. Popper (2008) alludes to the fact that channel catfish (*Ictalurus punctatus*) were included in the study and experienced hearing loss, and also to the fact that fish behavior was unaffected by the sonar. However, a detailed presentation of these results was not included in either Popper et al. (2007) or Popper (2008).

The only experiments having shown mortality in fish have been investigations on juvenile herring (*Clupea harengus*) when in close proximity to an intense mid-frequency active sonar source (Jørgensen et al., 2005; Sevaldsen and Kvadsheim, 2005). Even with the few studies available, it is becoming more established that those species tested at a greater distance from the sound source, where the sound level is below source level, show no mortality and possibly no long-term effects (Popper, 2008).

This is not to say, however, that any fish species, no matter what their hearing sensitivity, are not prone to injury as a result of exposure to mid-frequency active sonar. Individual juvenile fish with a swim bladder resonance in the frequency range of the operational sonars, and especially hearing specialists such as some clupeid species, may experience injury or mortality. The resonance frequency will depend on fish species, size and depth (McCartney and Stubbs, 1971; Løvik and Hovem, 1979). The swimbladder is a vital part of a system that amplifies vibrations that reach the fish's hearing organs, and at resonance the swimbladders may absorb much of the acoustic energy in the impinging sound wave (Sevaldsen and Kvadsheim, 2005). The resulting oscillations may cause mortality or harm the swimbladder itself or the auditory organs (Jørgensen et al., 2005). The physiological effect of sonars on adult fish is expected to be less than for juvenile fish because adult fish are in a more robust stage of development, the swim bladder frequencies will be outside the range of the frequency of mid-frequency active sonar, and adult fish have more ability to move from an unpleasant stimulus (Kvadsheim and Sevaldsen, 2005). A follow-on study to their earlier work that showed mortality in herring due to mid-frequency active sonar showed no reaction in open-ocean herring to mid-frequency active sonar (Kvadsheim et al., 2007). The age class of herring in this more recent study was not described. Interestingly, herring did react to playbacks of killer whale feeding sounds covering the same frequency band.

Kvadsheim and Sevaldsen (2005) determined the effects to the Atlantic herring population are likely to be minor considering the natural mortality rate of juvenile fish and the limited exposure of the fish to the sound source (Jørgensen et al., 2005). The investigators point out that continuous wave (CW) transmissions at the frequency band corresponding to the swim bladder resonance escalate the effect to juvenile herring significantly and suggested frequencies, depending on fish length, for which Atlantic herring will most likely be affected by CW signals (Table 3-11). Still, in the area of investigation, the effect of CW transmission at 225 dB on the juvenile herring population was determined to be small (0.1 percent) compared to daily natural mortality (5 percent). While CW signals will be used in the Proposed Action, the most commonly used signals will be FM, the significant threshold for mortality for which was determined to be 180-190 dB re 1 µPa for juvenile herring (Kvadsheim and Sevaldsen, 2005).

Table 3-11. Frequency Bands Most Likely to Affect Juvenile Herring

Atlantic Herring Length	Effective Frequency Band
2.5 to 3 cm	3 to 6 kHz
3 to 4 cm	2 to 5 kHz
5 to 6 cm	1.5 to 3 kHz
6 to 10 cm	1 to 3 kHz

cm = centimeter; kHz = kilohertz

Frequency bands for which a juvenile herring are likely to be affected during the use of CW-sonar signals. The effective frequency band is defined based on the expected resonance frequencies of the swim bladder of the juvenile Atlantic herring, as estimated from the length of the fish using the empirical model of Lovik & Hoven (1979) +/- 1 kHz bandwidth (McCartney and Stubbs, 1971) (based on Kvadsheim and Sevaldsen, 2005).

In a study of the response of fishes to active sonar ranging from 1.6 to 4.0 kHz, Jørgensen et al. (2005) observed the behavior of four unrelated marine species, (saithe [*Pollachius virens*], spotted wolffish [*Anarhichas minor*], cod [*Gadus morhua*], and Atlantic herring [*Clupea harengus*]). Jørgensen et al. (2005) concluded that, of the species studied, herring might be the only species of concern due to its increased hearing ability. Juvenile herring responded with startle behaviors from sonar signals around 170 dB re 1 μPa, but resumed normal activity after the first few pulses. However, in tests with received levels around 180 to 189 dB re 1 μPa, juvenile herring exhibited startle behaviors followed by abnormal swimming. In addition, strong distress was evident during presentation of a series of 100 frequency modulated (FM) sonar pulses at around 180 dB re 1 μPa. The other species of juvenile fishes did not exhibit startle responses, or any other behavioral evidence, from the mid-frequency sonar pulses as expected for fishes with no known auditory specializations for reception of frequencies above 1.0 kHz. Investigators suggested limiting the use of sonar in the range of 1.0 to 2.0 kHz at maximal operational source levels (greater than 200 dB) in areas of known juvenile herring abundance, because juvenile herring have swim bladder resonance frequencies in this frequency band.

Ultrasound detecting Clupeidae (such as American shad, blueback herring, alewife) with distributions overlapping the AFAST Study Area may have similar reactions to mid-frequency active sonar (as found by Jørgensen et al., 2005 and Kvadsheim and Sevaldsen, 2005) because of their similarities in hearing sensitivity. River herring (blueback herring and alewife) are listed by NMFS as a species of concern and could become listed as endangered or threatened species when enough information becomes available to indicate a need for endangered or threatened listing.

Studies have shown that low-frequency sound and ultrasound will alter the behavior of fish and can be used to deter fish away from potentially dangerous situations, such as turbine inlets of hydroelectric power plants (Knudsen et al., 1994). Stronger avoidance responses are exhibited from sounds in the infrasound range (0.005 to 0.010 kHz) rather than from 0.050 and 0.15 kHz sounds (Knudsen et al., 1992). In test pools, wild salmon will swim to a deeper section of the test pool, even if that deep section was near the sound source, when exposed to low-frequency sound. Ultrasound has been shown to cause some clupeid species to exhibit strong movement away from the sound source (Dunning et al., 1992; Mann et al., 1998; Ross et al., 1993), and it has also been observed to cause some clupeids to form tight schools (Mann et al., 1998; Nestler et al., 1992), which is a common defensive behavior (Astrup, 1999).

Culik et al. (2001) and Gearin et al. (2000) studied how sound may affect fish behavior by looking at the effects of mid-frequency sound produced from acoustic devices designed to deter marine mammals from gillnet fisheries. These devices generally produce sound in similar frequencies of mid-frequency active sonar devices. Gearin et al. (2000), studied adult sockeye salmon (*Oncorhynchus nerka*) and found that they exhibited an initial startle response, likely due to the placement of an inactive acoustic alarm (designed to deter harbor porpoises) in the test tank. The fish resumed their normal swimming pattern within 10 to 15 seconds. After 30 seconds, the fish approached the inactive alarm to within 30 cm (1 ft). The same experiment was conducted with the alarm active. The fish exhibited the same initial startle response from the insertion of the alarm into the tank; however, within 30 seconds, the fish were swimming within 30 cm (1 ft) of the active alarm. After five minutes of observation, the fish did not exhibit any reaction or behavior change except for the initial startle response (Gearin et al., 2000). This demonstrated that the alarm was either inaudible to the salmon, or the salmon were not disturbed by the mid-frequency sound (Gearin et al., 2000).

Wysocki and Ladich (2005) investigated the influence of sound exposure on the auditory sensitivity of two freshwater hearing specialists (goldfish [*Carassius auratus*] and lined Raphael catfish [*Platydoras costatus*]) and a freshwater hearing generalist (sunfish [*Lepomis gibbosus*]). Baseline thresholds showed greatest hearing sensitivity around 0.5 kHz in the goldfish and catfish and at 0.1 kHz in the sunfish. For the hearing specialists (goldfish and catfish), continuous white noise of 130 dB resulted in a significant threshold shift of 23 to 44 dB. In contrast, the auditory thresholds in the hearing generalist (sunfish) declined by 7 to 11 dB. It was concluded that acoustic communication and orientation of fishes, in particular of hearing specialists, may be limited by sound regimes in their environment. Studies have also found that hearing generalists normally experience only minor or no hearing loss when exposed to continuous sound, but that hearing specialists may be affected by sound exposure (e.g., acoustic communication might be restricted in noisy habitats) (Amoser and Ladich, 2003; Smith, et al., 2004a and 2004b).

The inability to hear ecologically important sounds due to the interference of other sounds (“masking”) has implications for reduced fitness; potentially leaving fish vulnerable to predators, unable to locate prey, sense their acoustic environment, or unable to communicate acoustically (McCauley et al., 2003). Pressure to detect predators is likely a significant driving force in the development of hearing abilities. Gannon et al. (2005) showed that bottlenose dolphins (*Tursiops truncates*) move toward acoustic playbacks of the vocalization of Gulf toadfish (*Opsanus beta*). Thus, dolphin prey, such as Gulf toadfish, could be under selective pressure to detect dolphin acoustic signals and use this information to adjust mate advertisement calling (Remage-Healey et al., 2006). Bottlenose dolphins employ a variety of vocalizations during social communication and foraging, including high-frequency whistles (5 to 20 kHz), echolocation clicks (20 to 100 kHz) and low-frequency pops. Toadfish may be able to best detect the low-frequency pops since their auditory frequency encoding is most robust below 1.0 kHz, and they have shown reduced levels of calling when bottlenose dolphins approach (Remage-Healey et al., 2006). Silver perch have also been shown to decrease calls when exposed to playbacks of dolphin whistles mixed with other biological sounds (Luczkovich et al., 2000). Results of the Luczkovich et al. (2000) study, however, must be viewed with caution because of the lack of clarity of which sound elicited the silver perch response (Ramcharitar et al., 2006b).

Communication signals, which loud sounds have the potential to mask, are a necessary aspect of some species’ ecology. The Sciaenids, which are primarily inshore fishes, are probably the most active sound producers among fish (Ramcharitar et al., 2001; Ramcharitar et al., 2006a). The frequency range of sciaenid sounds may span several kHz but the dominant frequency is generally between 0.1 and 1.0 kHz. Although there may be energy to higher frequencies in some species, the functional importance of these higher frequencies is unknown, and they may only be present as extraneous harmonics on the major frequency components in the sound (Ramcharitar et al., 2006a).

The ability to hear reproductive sound signals is necessary for population survival of some vocal fishes. The distance over which sound can be useful is often limited by the physics of sound travel underwater and therefore makes most reproductive sounds of limited use as an ecological cue over larger distances. Reproductive calls are often thought to be undetectable to fish within 20 m (66 ft) or less from the source, due to interactions with the surface and substrate (Mann and Lobel, 1997), although the detection distance will increase as water depth increases.

Also vulnerable to masking is navigation by larval fish. There is indication that larvae of some species navigate to juvenile and adult habitat by listening for fish choruses (the sound signature emitted from reefs and actively produced by adult fishes and invertebrates [Higgs, 2005]) and other sounds indicative of a particular habitat. In a study of an Australian reef system, it was determined the sound signature emitted from fish choruses were between 0.8 and 1.6 kHz (Cato, 1978) and could be detected 5 to 8 km (3 to 4 NM) from the reef (McCauley and Cato, 2000). This bandwidth is well within the detectable bandwidth of adults and larvae of many species of reef fish (Fay, 1988; Kenyon, 1996; Myrberg, 1980).

Thus, studies have indicated that acoustic communication and orientation of fish may be restricted by sound regimes in their environment. However, most marine fish species are not expected to able to detect sounds in the mid-frequency range of the operational sonars used in the Proposed Action, and therefore, the sound sources do not have the potential to mask key environmental sounds. The few fish species that have been shown to be able to detect mid-frequencies do not have their best sensitivities in the range of the operational sonars. Additionally, vocal marine fish largely communicate below the range of mid-frequency levels used in the Proposed Action.

There is no information available that suggests that exposure to non-impulsive acoustic sources results in significant fish mortality on a population level. Mortality has been shown to occur in one species, a hearing specialist, however, the level of mortality was considered insignificant in light of natural daily mortality rates. Experiments have shown that exposure to loud sound can result in significant threshold shifts in certain fish that are classified as hearing specialists (but not those classified as hearing generalists). Threshold shifts are temporary, and considering the best available data, no data exist that demonstrate any long-term negative effects on marine fish from underwater sound associated with sonar activities. Further, while fish may respond behaviorally to mid-frequency sources, this behavioral modification is only expected to be brief and not biologically significant.

3.9.2.1.2 Impulsive Sound (Detonation)

Few robust studies exist on the effects of impulsive sounds on fish (e.g., those produced by seismic airguns, pile driving, and detonations). Popper (2008) summarizes the results of fish exposed to sound from a seismic airgun array. The species included a hearing specialist, lake chub (*Couesius plumbeus*), and two hearing generalists, northern pike (*Esox lucius*) and broad whitefish (*Coregonus nasus*). The received exposure levels were determined as: average mean peak SPL 207 dB re 1 μPa RL; mean RMS sound level 197 dB re 1 μPa RL; and mean SEL 177 dB re 1 μPa^2s. The results showed temporary hearing loss of 20 to 25 dB for a hearing specialist and one hearing generalist, but no hearing loss to the second hearing generalist. Hearing for both species was fully recovered within 18 hours. There was no apparent damage to swim bladders or other body tissues. Subsequent examination of ear tissues showed no damage to sensory hair cells (Song et al., 2008).

In another study, McCauley et al. (2000) describe the effects of caged fish exposed to impulsive noise generated by seismic airguns. The results included behavioral, physiological, and pathological measurements. Behavioral responses included a startle response to short-range and high level signals (more pronounced in smaller fish and at received levels above 156 dB re 1 µPa rms), habituation to the sound over time, movement to lower portions of the cage, faster swimming, formation of tight groups, and a return to normal behavioral patterns 13 to 40 minutes after the airguns ceased operation. No significant physiological stress increases were reported. Some preliminary evidence of damage to hair cells was reported in constrained fish (i.e., fish that were approached at short range and were not able to flee), although the exposure level required to sustain damage was not established. The authors state that similar behavioral reactions, including changes in schooling and position in the water column, have been reported in other studies where fish were exposed to airguns and approaching vessels (e.g., Misund, 1993; Pearson et al., 1992; Olsen, 1990; Ona, 1988; Olsen et al., 1983). McCauley et al. (2000) suggest that alteration to swimming behavior could begin at received levels of 156 dB re 1 µPa rms, and that avoidance reactions could begin at 161 to 168 dB re 1 µPa rms.

A number of studies have investigated the effects of pile driving on fish, although most are in the gray literature and are not considered scientifically robust (Popper, 2008). Some studies suggest that the sounds produced during pile driving may kill fish close to the sound source, and there is evidence of accompanying tissue damage (Hastings and Popper, 2005; Caltrans, 2004, 2001). Source levels in such cases often exceed 230 dB re 1 µPa.

Relatively few studies exist regarding the effects of underwater detonations on fish. There currently is no set threshold for determining effects to fish from explosives other than mortality models. Fish that are located in the water column, in proximity to the source of detonation could be injured, killed, or disturbed by the impulsive sound and possibly temporarily leave the area. Govoni et al. (2003) reported organ damage in juvenile pinfish and spot exposed to underwater detonations at a distance of 3.6 m (11.8 ft), although there was little effect when the distance was increased to 7.5 m (24.6 ft). Continental Shelf Inc. (2004) presented a few generalities from studies conducted to determine effects associated with removal of offshore structures (e.g., oil rigs) in the GOMEX. Their findings revealed that at very close range, underwater explosions are lethal to most fish species regardless of size, shape, or internal anatomy. For most situations, cause of death in fishes has been massive organ and tissue damage and internal bleeding. At longer range, species with gas-filled swimbladders (e.g., snapper, cod, and striped bass) are more susceptible than those without swimbladders (e.g., flounders, eels). Studies also suggest that larger fishes are generally less susceptible to death or injury than small fishes. Moreover, elongated forms that are round in cross section are less at risk than deep-bodied forms; and orientation of fish relative to the shock wave may affect the extent of injury. Open water pelagic fish (e.g., mackerel) also seem to be less affected than reef fishes. The results of most studies are dependent upon specific biological, environmental, explosive, and data recording factors.

3.9.3 Occurrence of Marine Fish

3.9.3.1 Atlantic Ocean, Offshore of the Southeastern United States

3.9.3.1.1 VACAPES OPAREA

The VACAPES OPAREA is located in the southern portion of the MAB, which is the region between Cape Cod and Cape Hatteras. Ichthyofauna of the MAB is dynamic due to seasonal and climatic changes, varying life history strategies, hydrographic effects, fishing pressure, and natural cycles of abundance.

While distinct faunal assemblages exist in the cold-temperate waters north of Cape Cod and in the warm-temperate waters south of Cape Hatteras, few endemic fish species inhabit the variable MAB waters. The species composition of the MAB is diverse because many species, including commercially and recreationally important ones, migrate seasonally through this region to spawn. Northern (temperate) and southern (subtropical/tropical) fish populations also undergo extensive migrations through the OPAREA as they follow temperature isotherms. More than 300 fish species may occur in the MAB, with the majority being from southern (warm water) assemblages.

3.9.3.1.2 CHPT OPAREA

Nearly 700 fish species representing 149 families have been documented in the CHPT OPAREA. The dominant families of fish in the OPAREA include Serranidae (sea basses), Carangidae (jacks), Gobiidae (gobies), Bothidae (left-eyed flounders), Sciaenidae (drums and croakers), Triglidae (sea robins), Labridae (wrasses), Carcharhinidae (requiem sharks), Clupeidae (herrings), and Lutjanidae (snappers).

3.9.3.1.3 JAX/CHASN OPAREA

The fish assemblage of the JAX/CHASN OPAREA is represented by hundreds of species. Estuarine-dependent species, such as drums and croakers, are abundant in the OPAREA due to the extensive network of estuaries occurring along bordering states. Pelagic and coral reef-associated species are also well represented. Although coral reefs do not occur in the OPAREA, fishes typically associated with this habitat are common.

3.9.3.2 Atlantic Ocean, Offshore of the Northeastern United States

The Northeastern Atlantic Coast OPAREAs include the northern portion of the MAB, Georges Bank, and the Gulf of Maine. The MAB includes the region between Cape Cod and Cape Hatteras. Each of these three areas possesses distinct physical characteristics and species distributions. Typically, the number of different species decreases northward from the MAB to the Gulf of Maine; only half of the number of species occurs in the Gulf of Maine compared with the MAB. Seasonal temperature fluctuations are one of the primary factors that influence the distribution of species, especially fishes, in these marine regions. Approximately 300 species of fishes and over 260 species of macroinvertebrates exist here.

Approximately 113 species of fish inhabit the Gulf of Maine and Georges Bank. The majority encompasses temperate (i.e., species with temperature preferences below 15ºC [59ºF]) year-round fish species and includes members of the cod family (i.e., cod, haddock, and hake species) and various species of flounders. Alternatively, the MAB includes a high proportion of seasonal fish species that are subtropical-tropical species (i.e., species with preferences of temperatures above 20ºC [68ºF]). Tropical species only make up about 15 percent of the fish species. This portion of the Study Area also supports a variety of macroinvertebrates (e.g., ocean quahog, red deepsea crab, and Atlantic surfclam) and highly migratory pelagic fishes (e.g., billfishes, tunas, swordfish, and sharks). Many of the juvenile fishes and invertebrates that are commercially important species use estuaries and coastal waters for critical nursery and settlement habitat.

3.9.3.3 Eastern Gulf of Mexico

Over 550 species of fishes are found in the GOMEX. These fishes are taxonomically and ecologically diverse. Some species are economically important and support recreational and commercial fisheries. Only one species, the Gulf sturgeon (threatened status), is considered under the ESA and has been reported to occur in the eastern GOMEX.

The eastern GOMEX also includes a variety of habitats that, in turn, support a wide diversity of fishes. The key habitat features include coral reefs off southern Florida, a broad continental shelf off western Florida, submarine canyons (DeSoto and Mississippi), a major river delta (Mississippi) extending into the Gulf as part of Louisiana, and deepwater areas beyond the continental shelf. Physiographic and oceanographic features of the environment (e.g., salinity, primary productivity, bottom type, and currents) affect the distribution, abundance, and diversity of fishes in the GOMEX. The abundance and distribution of fish occurring in the eastern GOMEX are affected not only by their physical environment but also by the habitat available to them.

3.9.3.4 Western Gulf of Mexico

Fish assemblages and habitats within the western GOMEX are similar to that of the eastern GOMEX. Large predatory oceanic species associated with open water include marlins, sailfish, swordfish, tunas, mahi, wahoo, and sharks. Smaller prey species include flying fishes and halfbeaks. These species typically occur beyond the shelf edge and are often associated with fronts and eddies. *Sargassum* provides feeding and nursery habitat for many of the oceanic species (MMS, 2003a). Midwater or mesopelagic fishes are dominated by lanternfish, hatchet fish, and other deep-dwelling species that make extensive upward vertical migrations during the night from depths of up to 1,000 m (3,280.8 ft) (MMS, 2003a). Two Elkhorn coral colonies located in the Flower Garden Banks, on the edge of the outer continental shelf in the northwestern GOMEX, are essential constituents for an abundant fish habitat.

3.9.4 ESA-Listed Fish Species

Four endangered species (the shortnose sturgeon, subadult and adult Gulf sturgeon, smalltooth sawfish, and Atlantic salmon) may occur in the AFAST Study Area. Critical habitat has been designated for the Gulf sturgeon in the GOMEX, and has been proposed for the Gulf of Maine distinct population segment (DPS) of Atlantic salmon. A discussion of each of these endangered species, as well as critical habitat, is provided below.

3.9.4.1 Shortnose Sturgeon

The endangered shortnose sturgeon is an anadromous species that occurs in most major river systems along the eastern U.S. seaboard. The shortnose sturgeon spends most of the year in brackish or salt water and moves into fresh water only to spawn. The range generally extends from New Brunswick, Canada, to the St. Johns River in Florida. However, the shortnose sturgeon is a coastal/estuarine inhabitant and is not expected to be present in the training areas.

3.9.4.2 Gulf Sturgeon

Subadult and adult Gulf sturgeons may be found in the nearshore marine waters within close proximity to the boundary of the eastern GOMEX, particularly along the northern GOMEX. The Gulf sturgeon in this area has been observed 1.9 km (1 NM) from shore (Ross et al., 2002). Gulf sturgeons have been observed off the Suwannee River area as far as 16.7 km (9 NM) from shore (USFWS and NMFS, 2003). The Gulf sturgeon is not expected to be present in the training areas since it is a coastal inhabitant.

The USFWS has designated critical habitat for the Gulf sturgeon in the GOMEX. This protected habitat encompasses coastal waters from the mean high water line and out to 1.9 km (1 NM) offshore. The units for critical habitat include the Pearl River system in eastern Louisiana; the Pascagoula River system in Mississippi; the Escambia, Yellow, Apalachicola, Choctawhatchee, and Suwannee river systems in northwestern Florida; the Pensacola, Apalachicola, and Choctawhatchee bays in northwestern Florida; the Lake Borgne, Mississippi Sound, and Lake Pontchartrain systems in Mississippi and Louisiana; the Santa Rosa and Suwannee sounds in northwestern Florida; and the Florida Nearshore GOMEX area that stretches from Escambia to Gulf counties (50 CFR Part 226). The AFAST Study Area is located outside the Gulf sturgeon's critical habitat.

3.9.4.3 Smalltooth Sawfish

The smalltooth sawfish was listed under the ESA on April 6, 2003 following NMFS announcement on April 1, 2003 of a final determination for this species (NMFS, 2006d).

The smalltooth sawfish is one of two sawfish species in the waters of the United States. Once common throughout the GOMEX from Texas to Florida, their current distribution ranges primarily throughout peninsular and southern Florida. They are only commonly found in the Everglades and in shallow areas with mangrove forests in Florida Bay and the Florida Keys, as well as off southern Florida. They reside typically within 1.9 km (1 NM) of land in estuaries, shallow banks, sheltered bays, and river mouths with sandy and muddy bottoms. Occasionally, they are found offshore on reefs or wrecks and over hard or mud bottoms. The smalltooth sawfish feed on fish and crustaceans, using their long flat snouts to stun and kill their prey. Very little is known about their life history in Florida.

This shark relative was not highly targeted for direct commercial takings but was frequently entangled in fishing nets and caught in shrimp trawls. Once entangled, this sawfish has little chance for successful release. A study by C.A. Simpfendorfer (2000) suggests that the complete recovery of this species will take decades and possibly centuries due to their population size and slow reproductive potential. Habitat degradation has also contributed to their demise.

In May 2008, NMFS initiated a five-year review of the U.S. distinct population segment of smalltooth sawfish. The purpose of the review is to ensure that the listing classification remains accurate based on current information.

The smalltooth sawfish is not expected to be present within the training areas because its current distribution is limited to peninsular Florida, and it is only rarely found offshore.

3.9.4.4 Atlantic Salmon

The Atlantic salmon is an anadromous species that occurs in North American, European, and Baltic waters. The North American group generally ranges from Quebec to Long Island Sound. Atlantic salmon typically spend the first two to three years in fresh water, move to ocean habitatsfor the next two to three years, and then return to the natal river to spawn. Atlantic salmon originating in the U.S. are highly migratory between natal rivers and the northwest Atlantic Ocean. Movement into riverine habitat occurs from spring to fall, peaking in June. Historically, Atlantic salmon occurred in most major river systems north of the Hudson River. However, with the exception of a few populations, current distribution is limited to the eastern third of Maine’s coast. The Atlantic salmon Gulf of Maine DPS is currently listed as endangered under the ESA. The DPS was defined in 2000 as extending from the lower Kennebec River to (but not including) the mouth of the St. Croix River. In September 2008, NMFS and USFWS expanded the DPS to include all naturally reproducing wild and conservation hatchery populations from the Androscoggin River to the Dennys River. Atlantic salmon in Maine outside the Gulf of Maine DPS are designated as Species of Concern. The NMFS proposed critical habitat designation for Atlantic salmon in September 2008. The proposed habitat is comprised of 45 areas of river, stream, estuary, and lake habitats within the range of the Gulf of Maine DPS.

3.10 SEA BIRDS

This section focuses on birds (specifically sea birds) that occur in the AFAST Study Area. Seabirds are birds whose normal habitat and food source is the sea, whether they use coastal (nearshore) waters, offshore waters (continental shelf), or pelagic waters (open sea) (Harrison, 1983). While some seabirds are permanent residents to an area, other seabirds migrate to the area annually. Specifically, a migratory bird is any species or family of birds that lives, reproduces, or migrates within or across international borders at some point during its annual life cycle. These species are protected under the Migratory Bird Treaty Act (MBTA). This legislation was enacted to ensure the protection of shared migratory bird resources and currently protects a total of 836 bird species, 58 of which are currently legally hunted as game birds. The MBTA prohibits the take, possession, import, export, transport, selling, purchase, barter, or offering for sale, purchase or barter, any migratory bird, their eggs, parts, and nests, except as authorized under a valid permit. Current regulations authorize permits for takes of migratory birds for activities such as scientific research, education, depredation control, and lawful military readiness activities.

The states that border the eastern GOMEX and the East Coast lie within the Atlantic Flyway, a major migration route. During the fall and spring migratory seasons, large numbers of birds use the flyway. The coastal route of the Atlantic Flyway generally follows the shoreline, and migratory birds are typically associated with the coast. In the eastern GOMEX, however, there is a migratory route located offshore for passerines (i.e., land birds or song birds). However, most migratory land birds are nocturnal flyers, usually beginning at sunset and ending by dawn or when they find suitable habitat (Moore et al., 1995). Migration generally peaks in late April and early May, and the majority of migratory birds fly in large flocks at altitudes ranging from about 150 m (about 500 ft) to about 4,000 m (about 13,000 ft) above the surface of the water.

3.10.1 Foraging Habits

Overall, the majority of birds likely to occur in the AFAST Study Area feed in shallow waters and typically do not fully submerge themselves in the water. Rather, these seabirds plunge-dive from the air into the water or perform aerial dipping (the act of taking food from the water surface in flight) (Slotterback, 2002). Other common feeding methods include surface-seizing (sitting on water and taking food from surface), surface-dipping (swimming and then dipping to pick up items below the surface), jump-plunging (swimming, then jumping upward and diving under water), or picking up food while walking (Burger and Gochfeld, 2002). For example, shearwaters and petrels tend to skim waves in search of food, while the majority of gull and tern species eat only small fish and feed by plunge-diving head-first from flight, often from a hovering position (National Geographic, 2002; MMS, 2007i). The gull-billed tern and sooty tern, however, pluck food from the water's surface (MMS, 2007i). In addition, diving birds such as cormorants, anhingas, loons, and grebes generally feed by pushing themselves underwater with their wings and/or feet.

For seabirds that dive for food, research indicates that the longest recorded dive times were 30 seconds for the Northern gannets and 28 seconds for double-crested cormorants. Minimum dive times for Northern gannets and double-crested cormorants were 5 seconds and 19.3 seconds, respectively (Hatch and Weseloh, 1999; Mowbray, 2002). The Northern gannet also had the longest recorded dive depth of 15 m (49 ft) (Mowbray, 2002), followed by the pied-billed grebe with a maximum dive depth of 12 m (39 ft) (Muller and Storer, 1999), and the double-crested cormorant with 7.9 m (26 ft) (Hatch and Weseloh, 1999). However, the average dive length for the double-crested cormorant was approximately 5 m (16 ft) (Hatch and Weseloh, 1999). In addition, the wintering double-crested cormorants in Mississippi had much shorter dive durations with average dive times of 11.9 seconds in waters 1.4 m (5 ft) in depth. The mean dive depth for the pied-billed grebe was 3.69 m (12 ft) (Muller and Storer, 1999). A representative overview of foraging habits for birds likely to occur in the AFAST Study Area is presented in Table 3-12.

Table 3-12. Seabird Foraging Habits

Bird	Food Selection	Food Location of Feeding	Feeding Behavior
Anhingas *(Anhinga anhinga)*	Mainly slow-moving, laterally flattened fish, but also crayfish, amphibians, snakes, lizards, mollusks, leeches, and aquatic insects	Shallow, freshwater habitats	Surface dipping and side-spearing
Band-Rumped Storm Petrels *(Oceanodroma castro)*	Squid and small fish from ocean surface; few crustaceans	Internal wave crests at or just below surface	Aerial dipping
Bonaparte's Gulls *(Larus philadelphia)*	Small fish, krill, amphipods, and insects such as snails, marine worms, grasshoppers, beetles, locusts, ants, and bees	shallow (< 3 ft) habitats including lakes, ponds, muskegs, rivers, large bays, coastal estuaries, tidal rips, surf, and open ocean	Plunge-diving, aerial dipping, surface-seizing, surface-dipping, jump-plunging, and walking
Bridled Terns *(Sterna anaethetus)*	Primarily small schools of fish near the ocean's surface, crustaceans, and aquatic insects	Air-sea boundary layer, typically 3 to 7 ft below and on sea surface	Aerial dipping (pecking)
Brown Pelicans *(Pelecanus occidentalis)*	Primarily small schools of fish near the ocean's surface such as menhaden and mullet along Atlantic and Gulf Coasts	Shallow habitats within 11 NM of shore	Plunge-dives and aerial dipping
Double-Crested Cormorants *(Phalacrocorax auritus)*	Mostly slow-moving schooling species; occasionally insects, amphibians, and crustaceans	Shallow open water (< 26 ft deep) and close to shore (< 3 NM)	Plunge-diving
Forster's Tern *(Sterna forsteri)*	Primarily small fish; some arthropods	Shallow saltwater estuaries and coastal areas (< 3 ft), over flood-tide mudflats, marshes, lakes, and water channels	Aerial dipping
Gull Billed Terns *(Sterna nilotica)*	Terrestrial and aquatic animals such as insects, lizards, fish, and chicks of other birds	Beaches and salt marshes, inland over plowed fields, and shrubby habitats	Does not generally plunge-dive; instead plucks food from the water
Horned Grebes *(Podiceps auritus)*	Fish and crustaceans, including amphipods and crayfish	Shallow- to moderately deep (<20 ft) habitats	Surface-swimming and plunge-diving
Laughing Gulls *(Larus atricilla)*	Aquatic and terrestrial invertebrates such as earthworms, flying insects, beetles, snails, and crabs; fish; squid; garbage; and berries	Coastal edge and inland	Surface-dipping, walking, plunge-diving, and pirating food from other species
Least Terns *(Sterna antillarum)*	Small fish, shrimp, and other invertebrates	Shallow water habitats such as marine coasts, bays, lagoons, estuaries, river and creek mouths, tidal marshes, and lakes	Plunge-diving
Northern Gannets *(Morus bassanus)*	Surface-schooling fish such as mackerel and herring	Shallow continental-shelf waters	Primarily plunge-diving
Parasitic Jaegers *(Stercorarius parasiticus)*	Depends on breeding populations, but can include birds, eggs, and rodents	Near colonies of nesting seabirds	Plunge-diving and pirating food from other species

Table 3-12. Seabird Foraging Habits Cont'd

Bird	Food Selection	Food Location of Feeding	Feeding Behavior
Pied-Billed Grebes *(Podilymbus podiceps)*	Readily available fish such as crayfish, aquatic insects, and their larvae	Open water among rooted aquatic plants, near shoreline, and amongst vegetation	Plunge-diving
Red-Throated Loons *(Gavia stellata)*	Primarily live, marine fish	Coastal, tidal estuaries, mudflats in streams, rivers, and lakes	Peering from surface and/or diving
Sandwich Terns *(Sterna sandvicensis)*	Small marine fish, squid, and crustaceans	Coastal marine areas such as open ocean and bays, inlets, and outflows; usually < 1 NM off shore	Plunge-diving
Sooty Terns *(Sterna fuscata)*	Small pelagic fish and squid; feeds over large predatory fish including tuna	Within 4 in of the ocean surface, far at sea in tropical, and subtropical oceanic waters	Plunge-diving

ft – feet; in – inch; NM – nautical mile

Sources: Braune, 1987a, Frederick and Siegel-Causey, 2000; Slotterback, 2002; Burger and Gochfeld, 2002; Burger and Gochfeld, 2006; Haney et al., 1999; Shields, 2002; Hatch and Weseloh, 1999; McNicholl et al., 2001; Parnell et al., 1995; Palmer, 1962; Stedman, 2000; Burger, 1996; Thompson et al., 1997; Mowbray, 2002; Wiley and Lee, 1999; Muller and Storer, 1999; Barr et al., 2000; Shealer, 1999; Schreiber et al., 2002.

3.10.2 Seabird Hearing

Little is known about the general hearing or underwater hearing capabilities of sea birds, but research suggests an in-air maximum auditory sensitivity between 1 and 5 kHz for most bird species (NMFS, 2003a).

3.10.3 Occurrence of Seabirds

The following sections provide information on seabirds and migratory birds that are not protected under the ESA. Section 3.10.4 describes the threatened and endangered seabird species that may potentially occur in the AFAST Study Area.

3.10.3.1 Atlantic Ocean, Offshore of the Southeastern United States

The Atlantic Ocean, offshore of the southeastern United States, is populated by both resident and migratory seabirds. Seabirds known to use the coastal and offshore waters of the southeastern OPAREAs are categorized as summer, winter, or permanent residents.

Summer residents are present and breed during spring/summer months. Examples include black-capped petrels, various shearwaters, Wilson's storm-petrels, band-rumped storm-petrels, anhingas (VACAPES, CHPT, and CHASN OPAREAs), south polar skuas, sandwich terns, Forster's terns, gull-billed terns, least terns, bridled terns, and sooty terns (National Geographic, 2002). Winter residents are found only during winter months. Examples include red-throated loons, common loons, horned grebes, northern gannets, parasitic jaegers, and Bonaparte's gulls

(National Geographic, 2002). Permanent residents are found year-round. Examples include pied-billed grebes, double-crested cormorants, brown pelicans, anhingas (JAX OPAREA), and laughing gulls (National Geographic, 2002).

3.10.3.2 Atlantic Ocean, Offshore of the Northeastern United States

The Atlantic Ocean, offshore of the northeastern United States, is populated by summer and winter residents. Seabirds known to use the coastal and offshore waters of the northeastern OPAREAs are categorized as summer, winter, or permanent residents.

Summer residents include pied-billed grebes, sooty shearwaters, Cory's shearwaters, greater shearwaters, manx shearwaters, Audubon's shearwaters, Wilson's storm-petrels, double-crested cormorants, south polar skuas, brown pelicans, laughing gulls, roseate terns, common terns, and least terns (National Geographic, 2002). Winter residents include common and red-throated loons, horned grebes, red-necked grebes, great cormorants, northern fulmars, northern gannets, great skuas, black-legged kittiwakes, Bonaparte's gulls, black-headed gulls, little gulls, and ringed-billed gulls (National Geographic, 2002). Red phalaropes and pomarime jaegers are found pelagically in the region during nonbreeding seasons (Alsop, 2001). Permanent residents include great black-backed gulls and herring gulls (Blodget, 2002).

3.10.3.3 Eastern Gulf of Mexico

The eastern GOMEX is populated by both resident and migratory seabirds. While some species of seabirds inhabit only pelagic habitats in the GOMEX (e.g., boobies, petrels and shearwaters), most Gulf seabird species inhabit waters of the continental shelf and adjacent coastal and inshore habitats. The GOMEX seabirds are categorized as summer, winter, or permanent residents.

Summer residents include Audubon's shearwaters, Wilson's storm-petrels, magnificent frigatebirds, sandwich terns (Florida Panhandle), least terns, and sooty terns (National Geographic, 2002). Winter residents include common loons, horned grebes, northern gannets, great cormorants, pomarine jaegers, parasitic jaegers, Bonaparte's gulls, and ringed-billed gulls (National Geographic, 2002). Permanent residents include pied-billed grebes, anhingas, double-crested cormorants, brown pelicans, laughing gulls, royal terns, and Caspian terns (National Geographic, 2002).

3.10.3.4 Western Gulf of Mexico

The western GOMEX is populated by both resident and migratory seabirds. Seabirds known to use the coastal and offshore waters of this area are categorized as summer, winter, or permanent residents.

Summer residents include Audubon's shearwaters, Wilson's storm-petrels, magnificent frigatebirds, least terns, and sooty terns (National Geographic, 2002). Winter residents include common loons, horned grebes, eared grebes, northern gannets, pomarine jaegers, parasitic jaegers, Bonaparte's gulls, and ringed-billed gulls (National Geographic, 2002). Permanent residents include pied-billed grebes, least grebes, anhingas, neotropic cormorants, double-crested cormorants, brown pelicans, laughing gulls, sandwich terns, royal terns, and Caspian terns (National Geographic, 2002).

3.10.4 Threatened and Endangered Seabirds

The following sections provide information on birds throughout the AFAST Study Area that are listed under the ESA.

Of the birds that may occur along the East Coast and GOMEX, five species are currently listed as federally endangered or threatened:

- Bermuda petrel
- Brown pelican
- Least tern
- Roseate tern
- Piping plover

The occurrence of these birds is described in the following sections.

3.10.4.1 Bermuda Petrel

The Bermuda petrel (*Pterodroma cahow*) is an endangered seabird that inhabits and nests in Bermuda and its surrounding waters but has been observed off the Carolina Capes following West Indian hurricanes (MMS, 2007g). The Bermuda petrel breeds primarily on rocky islets in Castle Harbor, Bermuda, from January through June. After breeding season, it is thought that these birds may follow the warm waters of the Gulf Stream into the Atlantic (Balloffet et al., 2006; BirdLife International, 2006; National Audubon Society, 2008). It is thought that the Gulf Stream waters provide a foraging ground for this species and annual sightings of small numbers (no more than four) have been reported and confirmed off Hatteras, North Carolina since 1995 (Hunter et al., 2006; Patteson and Brinkley, 2004). Current threats to this species include competition for nest sites with the white-tailed tropic bird, light pollution, sea-level rise, and increasing tropical storms (Balloffet et al., 2006).

3.10.4.2 Brown Pelican

The brown pelican (*Pelecanus occidentalis*) is an endangered marine bird that occurs in the south and mid-Atlantic regions. This species is a colonial nester that uses relatively undisturbed coastal islands in salt and brackish waters to feed and rear their young. It feeds by diving for its prey (MMS, 2007g).

The eastern brown pelican (*Pelicanus occidentalis carolinensis*) is one of two pelican species occurring in North America. It inhabits coastal habitats and forages within coastal waters and waters of the inner continental shelf, typically less than 32 km (17.3 NM) from the coast. It feeds entirely upon fishes captured by plunge diving in coastal waters. Subsequent to the ban of the insecticide dichlorodiphenyltrichloroethane (DDT), the population of brown pelicans and their habitat in Alabama, Florida, Georgia, North and South Carolina, and points northward along the Atlantic coast were removed from the endangered species list in 1985. However, within the remainder of the range, which includes coastal areas of Texas, Louisiana, and Mississippi, where populations are not secure, the brown pelican remains listed as endangered. No critical habitat has been designated for this species (MMS, 2007i; MMS, 2007g).

Brown pelicans are considered year-round residents to the eastern Texas coast (National Geographic, 2002).

3.10.4.3 Least Tern

The least tern (*Sterna antillarum*) is the smallest North American tern. Three subspecies of New World least terns were recognized by the American Ornithologists' Union (1957). These include the interior least tern (*Sterna antillarum athalossus*), the eastern or coastal least tern (*Sterna antillarum antillarum*), and the California least tern (*Sterna antillarum browni*). According to the *Federal Register*, "Because of the taxonomic uncertainty of least tern subspecies in eastern North America, the [U.S. Fish and Wildlife] Service decides not to specify the subspecies in this final rule. Instead the Service designates as endangered the subspecies of least terns (hereinafter referred to as interior least tern) occurring in the interior of the United States [*Sterna antillarum athalossus*]" (MMS, 2007g).

The entire Atlantic and Gulf coasts are part of the least tern's breeding range. However, the least tern nests in colonies on beaches and sandbars (National Geographic, 2002). Since AFAST active sonar activities occur away from beaches and sandbars under all four alternatives, it is unlikely that least terns will be encountered.

3.10.4.4 Roseate Tern

The endangered roseate tern (*Sterna dougallii*) nests on rocky coastal islands, outer beaches, or salt marsh islands along the northeastern U.S. coast (National Geographic, 2002; USFWS, 2007b). Roseate terns are plunge-divers, typically feeding occurs in waters less than 10 m (32.8 ft) in depth over sand (USFWS, 2007b). Threats to this species include habitat loss and disturbance, predation, egg collection (locally), and competition from expanding gull populations (MMS, 2007g). Since AFAST active sonar activities in the northeast will occur over the open ocean away from beaches and shallow waters, it is unlikely that roseate terns will be encountered.

3.10.4.5 Piping Plover

The piping plover (*Charadrius melodus*) is a shorebird that inhabits coastal sandy beaches and mudflats. This species has experienced major declines over its entire range, followed by some recovery. Some regional declines are still occurring. Strong threats related primarily to human activity, disturbance by humans, predation, and development pressure are pervasive threats along the Atlantic coast (MMS, 2007g). It is listed as a result of historic hunting pressure and loss and degradation of habitat (66 *Federal Register* [FR] 36038-36079) (MMS, 2007g). Since AFAST active sonar activities will occur away from beaches it is unlikely that piping plovers will be encountered.

3.11 MARINE INVERTEBRATES

Invertebrates can be described as animals that lack a backbone or spinal column. Invertebrates include 97 percent of all animal species (excluding vertebrates such as fish, reptiles, amphibians, birds, and mammals) and range from simple animals, such as sponges and flatworms, to complex animals such as arthropods and mollusks.

Several invertebrate species with occurrence in the AFAST Study Area are managed as fishery resources, and have designated EFH. The managing councils are identified below. Refer to Section 3.8 for a more complete discussion of EFH.

- Atlantic sea scallop: NEFMC
- Deep-sea red crab: NEFMC
- Long-finned and short-finned squid: managed as part of the MAFMC's Atlantic mackerel, squid, and butterfish Management Unit
- Surfclam and ocean quahog: MAFMC
- Coral, coral reefs, and live/hardbottom habitats: managed jointly by the SAFMC and the GMFMC
- Golden crab: SAFMC
- Shrimp: managed jointly by the SAFMC (5 species) and the GMFMC (4 species)
- Calico scallop: SAFMC
- Spiny lobster: managed jointly by the SAFMC and the GMFMC
- Stone crab: GMFMC

According to the NRC, very little information exists regarding the hearing capability of marine invertebrates, although a number of cephalopods (e.g., octopods and squid), as well as crustaceans (e.g., crabs), possess statocytes, or structures that resemble the ears of fishes (NRC, 2003). It has been determined that prawns can hear between 100 and 3,000 Hz, with best hearing capabilities at 100 Hz (Lovell et al. 2005). (Prawn hearing capabilities are similar to those of generalist fish.) In addition, one species of squid exhibited behavioral reactions to sounds from seismic airguns at received levels exceeding 156 to 161 dB re 1 μPa mean square pressure (rms) (McCauley et al., 2000). However, Wilson et al. (2007) exposed squid to sound pressure levels ranging from 199 to 226 dB re 1 μPa to determine whether toothed whale echolocation clicks can incapacitate squid and whether squid can detect and respond to such clicks. No behavioral changes were reported in the squid when exposed to the two types of echolocation clicks. The statocytes may assist with determining the species' head position (NRC, 2003). Some species of semiterrestrial fiddler crabs and ghost crabs detect sounds and use sounds to communicate; as such, it is possible that marine crabs are also capable of detecting sounds, although it has not been proven (NRC, 2003).

3.12 MARINE PLANTS AND ALGAE

3.12.1 Marine Plants

Ecologically speaking, marine plants are classified as primary producers; thus, they have the ability to use inorganic materials to produce organic compounds through photosynthesis. Ecologists use “primary production” to describe an increase in biomass of higher plants and by analogy, aquatic ecologists have used it to describe micro- as well as macrophytic algal production (American Society of Limnology and Oceanography, Inc, 1988).

There are several categories of marine plants; these categories include seagrasses, mangroves, and algae. Seagrasses, such as Johnson’s seagrass, are true flowering plants that have adapted to life in the marine environment.

Seagrasses are among the most productive ecosystems in the world and perform a number of irreplaceable ecological functions that range from chemical cycling and physical modification of the water column and sediments, to providing food and shelter for commercial, recreational, and ecologically important organisms. This is evident not only by the scientific literature but also by the increasing public notices occurring in newspapers regarding their loss (e.g., in Chesapeake Bay and Florida Bay). With the exception of Georgia and South Carolina, there are a minimum of 13 species of seagrass recognized as occurring in U.S. territorial waters. Off Georgia’s and South Carolina’s coast, freshwater inflow, high turbidity, and tidal amplitude inhibit their growth. Mangroves are also true flowering plants and are found in coastal waters of varying salinities.

Since marine plants are submerged, they are susceptible to damage by human activities such as nutrient loading, light reduction, propeller scarring, and dredge-fill operations (Stephan and Bigford, 1997). Dredge and fill operations are no longer a primary cause of major losses of seagrass habitat due to the recognition of their ecological role and the vigilance of state and federal regulatory activities relative to permits. Propeller scouring and fishing gear-related effects remain a concern. This physical damage is long-lasting and often results in sediment destabilization and continued habitat loss. The increasing number of small boats traveling estuarine and coastal waters has made the prop-scarring effects more widespread, and there has been a recognized need in some quarters for both enhanced management of these systems and increased awareness by the boating public.

3.12.2 Algae

Algae are not true flowering plants and range in size from microscopic phytoplankton to large seaweed species (Thayer et al., 1997). As such, they provide the basis for most of the aquatic food chain. *Sargussum* can be described as a generally planktonic macroalgae or brown algae (seaweed). *Sargussum* originates in the Sargasso Sea, a region of the Central Atlantic. The Sargasso Sea is in the middle of the Atlantic Ocean and covers some 3 million km^2 (2 million square miles [mi^2]) between the West Indies and the Azores. It is encircled by the Gulf Stream and the North Equatorial Current. This causes the oval-shaped sea to move in a slow, clockwise drift. The Sargasso Sea is also known as “the floating desert” (Florida Department of Environmental Protection [FDEP], 2007). Tiny air bladders keep the *Sargassum* afloat. It can form streamers that stretch for miles along the boundaries between water masses, or it can form big yellow and brown "mats" that cover large areas of the surface. Strong currents around the Sargasso Sea can carry *Sargassum* around the world. *Sargassum* is commonly found in the beach drift near *Sargassum* beds where they are also known as Gulfweed (FDEP, 2007).

Thick masses of *Sargassum* provide an environment for a distinctive and specialized group of marine biota, many of which are not found elsewhere in the world (Science and the Sea, 2007). Specifically, planktonic *Sargassum* serves as a temporary habitat for four species of sea turtle hatchlings, as well as larval and juvenile stages of over 100 fish species. Fish are attracted to the drifting algal mats for a number of reasons, including use as a foraging area, for protection from larger predators, as a spawning ground, and as a nursery habitat. The habitat created by *Sargassum* aggregations also supports a diverse and highly adapted resident assemblage of marine organisms such as fungi, micro- and macro-epiphytes, hydroids, and crustaceans.

In addition, *Sargassum* provides food and shelter to juvenile sea turtles. Sea turtle hatchlings are known to associate with pelagic *Sargassum* habitat during their "lost years" when they drift along with the planktonic mats. This association is thought to play a vital role in the life of young turtles. Any *Sargassum* mats drifting at sea have the potential to host young sea turtles, since both are found with currents and can travel for long distances from their points of origin.

3.12.3 Occurrence of Marine Plants and Algae

In the area managed by the Atlantic States Fishery Management Council, eelgrass (*Zostera marina*) dominates, with two other species also occurring: Cuban shoalgrass (*Halodule wrightii*) in North Carolina and widgeon grass (*Ruppia maritime*), which is cosmopolitan. Specifically, areas of seagrass concentration in North Carolina include southern and eastern Pamlico Sound, Core Sound, Back Sound, Bogue Sound, and the numerous small southern sounds located behind the beaches in Onslow, Pender, Brunswick, and New Hanover counties. In addition, areas of seagrass concentration along Florida's east coast include Mosquito Lagoon, Banana River, Indian River Lagoon, Lake Worth and Biscayne Bay. Shoalgrass is a subtropical species that has its northernmost distribution at Oregon Inlet, North Carolina. Eelgrass, a temperate species, has its southernmost distribution in North Carolina.

In the GOMEX, turtlegrass (*Thalassia testudinum*) and manatee grass (*Syringodium filiforme*) are dominate species along with several species of *Halophila*. One species of seagrass, Johnson's seagrass (*Halophila johnsonii*), was listed in 1999 as a threatened species under the ESA. The presence of *Sargassum* is transient (temporary), unpredictable, and dependent on prevailing surface currents. Aggregations of *Sargassum* can be found throughout tropical areas of the world and are often the most obvious macrophyte in nearshore areas where *Sargassum* beds often occur near coral reefs. They grow subtidally and attach to coral, rocks, or shells in moderately exposed or sheltered rocky or pebble areas. In some cases (e.g., the Sargasso Sea), there are floating populations of *Sargassum* (FDEP, 2007). The GOMEX is second to the Sargasso Sea in the quantity of *Sargassum* present in the area. Moreover, the Florida Keys and its smaller islands are well known for their high levels of *Sargassum* covering their shores (FDEP, 2007).

3.12.4 Fishery Management Plan for Pelagic Sargassum Habitat

In 2003, the SAFMC approved the "Fishery Management Plan for Pelagic Sargassum Habitat in the South Atlantic Region." This plan regulates the commercial harvesting of *Sargassum* south of North Carolina and South Carolina and prohibits harvesting *Sargassum* within 161 km (86.8 NM) from shore (SAFMC, 2007).

3.13 NATIONAL MARINE SANCTUARIES

The National Marine Sanctuary Program (NMSP) designates and manages national marine sanctuaries. These areas of the marine environment possess special national significance due to their conservation, recreational, ecological, historical, scientific, cultural, archeological, educational, or esthetic qualities. The primary objective of the NMSP is to manage marine resources. These include coral reefs, sunken historical vessels or unique habitats (NMSP, 2007e). The NMSP currently manages 14 marine protected areas. Five of these areas are located within the AFAST Study Area. A description of each of these sanctuaries along with a brief description of regulations is provided in subsequent paragraphs. Regulations governing management of each sanctuary can be found in 15 CFR 922. In general, sanctuary regulations prohibit, from within the boundaries of any sanctuary, the discharging or depositing of any material or other matter (although specific discharge prohibitions and exceptions vary from site to site). In addition, it is prohibited to discharge or deposit any material outside a sanctuary that could subsequently enters the sanctuary and injure a sanctuary resource or quality. Further, most sanctuaries prohibit (with some exemptions) drilling into, dredging, or otherwise altering the seabed. Sanctuary specific prohibitions relative to military operations are included following the description of each respective sanctuary.

3.13.1 Atlantic Ocean, Offshore of the Southeastern United States

In 1973, a group of scientists aboard a Duke University Research vessel located the remains of a shipwreck nearly 70 m (230 ft) below the surface and approximately 26 km (14 NM) off Cape Hatteras in North Carolina. The following year, it was confirmed that the shipwreck the scientists located was the USS Monitor.

The USS Monitor was a steam-powered ironclad ship that was equipped with a rotating gun turret. The vessel is famous for its design and its part in the 1862 Battle of Hampton Roads against the Confederate ironclad *Virginia*. The battle resulted in minor damage to either vessel and resulted in a draw. Later, in the same year of the battle, the USS Monitor sank in a storm off Cape Hatteras while in transit from Rhode Island to North Carolina for repairs (NMSP, 2007d). Although, the Monitor's brief career was fairly uneventful, with the exception of the engagement with the CSS Virginia, the vessel remains an important symbol for its role in shaping U.S. naval history.

The Monitor National Marine Sanctuary was established in 1975 in order to preserve the historical and cultural artifacts of one of the most famous ships that have ever been built for naval warfare. The location of the sanctuary is defined by the shipwreck and the surrounding area, which is composed of a column of water extending from the ocean's surface to the seabed and is 1.85 km (1 NM) in diameter. The small size of the sanctuary limits the number of marine life that permanently inhabits the area. However, many species pass through the area, and a small ecosystem has developed around the wreck site following the permanent establishment of several organisms on the wreck (NMSP, 2007d).

A permit is required to gain access to the shipwreck. Permits are typically limited to scientific research visits and in some cases, a special-use permit will be granted for nonresearch visits. Other regulations prohibit anchoring, stopping, and drifting within the sanctuary, disturbing the seabed by conducting underwater detonation, drilling, laying cable, and trawling (NMSP, 2007d). Regulations relative to military operations is the prohibition of anchoring in any manner, stopping, remaining, or drifting without power; or the detonating of any explosive or explosive mechanism below the surface of the water.

Gray's Reef became a national marine sanctuary in 1981 and is one of the three marine sanctuaries that make up the Southeast Region. It is one of the largest nearshore sandstone reefs in the southeastern United States and is an important calving ground for the endangered North Atlantic right whale. The 58 km^2 (17.5 NM^2) that constitute Gray's reef is located 32.4 km (17.5 NM) off Sapelo Island, Georgia, and is the only natural area protected off the Georgia coast.

Gray's Reef is popular for recreational fishing and diving because of its "live bottom habitat" that supports an unusual assemblage of organisms and temperate and tropical marine flora and fauna that attach to the rocky platform. The area is characterized by a series of rock ledges and sand expanses that have created deep burrows, troughs, and caves that attract an array of different species including black sea bass, snapper, grouper, and mackerel. Since the reef lies in a transition area between temperate and tropical waters, the composition of fish population changes seasonally. Dominant invertebrates that inhabit the area include sponges, barnacles, sea fans, hard coral, crabs, lobsters, and snails. The area supports endangered and threatened species such as loggerhead turtles, which are present year-round. The reef is also part of the only known winter calving grounds for the North Atlantic right whale (NMSP, 2007c).

Sport fishing and diving occurs year-round at Gray's Reef. However, certain types of equipment are restricted in the area such as wire fish traps, bottom trawls, and explosives. Commercial fishing, military activities, mineral extraction, and ocean dumping is restricted. Also, prohibited in the area is any alteration of the seabed including removal or damage to bottom formations and other natural or cultural resources and disposal of materials or substances (NMSP, 2007c). Regulations relative to military operations are the prohibition of underwater explosives or devices that would threaten, destroy, cause injury, or loss of any marine organism.

3.13.2 Atlantic Ocean, Offshore of the Northeastern United States

Stellwagen Bank is located on the eastern edge of Massachusetts Bay, which lies between Cape Ann and Cape Cod, in the southwest corner of the Gulf of Maine. The bank is a characterized as shallow sandy feature that extends for nearly 31 km (16 NM) and is approximately 10 km (5 NM) across at is widest point. It is the bay's most prominent feature and the centerpiece of the Stellwagen Bank National Marine Sanctuary.

As a result of the 1992 reauthorization and amendment to Title III of the Marine Protection, Research and Sanctuaries Act (MPRSA), the Stellwagen Bank National Marine Sanctuary was established. Stellwagen Bank is New England's first sanctuary and the nation's twelfth. The sanctuary encompasses a total of 2,191 km^2 (638 NM^2) and occurs entirely within federal waters. Stellwagen Bank was designated for a national marine sanctuary for a variety of reasons but one of the most notable reasons is the two distinct peak productivity periods that produce a complex system of midwater and benthic habitats. The area provides cover and anchoring locations for invertebrates and also provides feeding and nursery grounds for other types of species, particularly a variety of endangered species such as leatherback and Kemp's ridley sea turtles, and the humpback, right, sei, and fin whales (NMSP, 2007f). The abundant variety of species supports a variety of activities including whale watching, bird watching, boating, and commercial and sport fishing.

Another important feature of the Stellwagen Bank National Marine Sanctuary is the presence of nearly 50 shipwrecks. Major shipping lanes to Boston go through the sanctuary creating a constant flow of large vessel traffic. However, a shift in the shipping lanes took effect on 1 July 2007. The International Maritime Organization approved a 12-degree northward adjustment in shipping lanes through the sanctuary in order to reduce the threat of ship strikes to endangered whales in the sanctuary. The relocation will avoid popular right whale, fin, and humpback whales feeding grounds and is expected to reduce the risk of ship strikes to right whales by 58 percent and up to 81 percent for all other large whale species (NMSP, 2007g).

The NOAA's office of Law Enforcement, the U.S. Coast Guard, and the Massachusetts Environmental Police are responsible for enforcing federal laws in the sanctuary. Recreational fishing, whale watching, and diving are regulated activities in the sanctuary. There is no permit required for fishing; however, regulations govern the number of species, and types of species caught. There are three sanctuary specific regulations for diving, which include no alteration to seabed, no transportation of a historical resource, and no possession of a historical or natural resource (NMSP, 2007g). Regulations relative to military operations are the prohibition of operating a vessel (i.e., water craft of any description capable of being used as a means of transportation), or an activity that would threaten or actually destroy, cause the loss of, or injury to a sanctuary resource (e.g., marine mammal, marine reptile, seabird, historical resource).

3.13.3 Eastern Gulf of Mexico

The Florida Keys are located on the southern tip of the Florida peninsula and extend from the southern end of Key Biscayne to 145 km (78 NM) north of Cuba. Adjacent to and nearly 9.7 km (5.2 NM) seaward of the 203 km (126 mi) of the archipelago, lies the most extensive and only living coral reef in North America. The coral reef is a complex marine ecosystem that supports a unique and diverse biological community.

The Florida Keys National Marine Sanctuary (FKNMS) was designated in 1990 due to concerns for the health of the coral reefs. The FKNMS encompasses 9,959 km^2 (2,900 NM^2), which surrounds the entire chain of islands and includes the Florida Bay, the GOMEX, and the Atlantic Ocean (NMSP, 2007a).

There are sanctuary-wide regulations as well as regulations by zone. Sanctuary-wide regulations focus on reducing direct and indirect threats to the reef by focusing on protecting critical habitats and resources and improving water quality. The zones in the sanctuary include the Western ambo Ecological Reserve (ER), 18 Sanctuary Preservation Areas (SPA), 27 Wildlife Management Areas (WMA), 4 Special Use Areas, and existing management areas (NMSP, 2007a). Regulations relative to military operations are the prohibition of activities that would threaten or actually destroy, cause the loss of, or injury to a sanctuary resource (e.g., marine mammal, marine reptile, seabird, historical resource).

3.13.4 Western Gulf of Mexico

The Flower Garden Banks National Marine Sanctuary is located in the northwestern GOMEX nearly 177 km (96 NM) off the coast of Texas and Louisiana and harbors the northernmost coral reefs in the United States. The area serves as a regional reservoir of shallow water Caribbean reef fish and invertebrate, making it one of the premier diving destinations around the world.

Designated in 1992, the sanctuary serves to protect the coral reef ecosystem and its associated biological communities from increasing human activities such as oil and gas exploration. The sanctuary is made up of three separate areas, known as East Flower Garden, West Flower Garden, and Stetson Banks. The total area of the sanctuary is approximately 145 km^2 (42 NM^2) and supports nearly 280 different documented fish species, loggerhead and hawksbill sea turtles, and a variety of shark and ray species (NMSP, 2007b).

The Flower Garden Banks National Marine Sanctuary is protected by mooring buoys that prevent anchor damage to the habitats. Regulations relative to military operations are the prohibition of activities that would threaten or actually destroy, cause the loss of, or injury to any coral or other bottom formation, coralline algae or other plant, marine invertebrate, brine-seep biota, or carbonate rock within the sanctuary.

3.14 AIRSPACE MANAGEMENT

Airspace management is defined as the direction, control, and handling of flight operations in the volume of air that overlies the geopolitical borders of the United States and its territories. Airspace is a resource managed by the Federal Aviation Administration (FAA), which has established policies, designations, and flight rules to protect aircraft in the airfield and en route environment, in Special Use Airspace (SUA) identified for military and other governmental activities, and other military training airspace.

The management of airspace considers how airspace is designated, used, and administered to best accommodate the individual and common needs of military, commercial, and general aviation. Because of these multiple and sometimes competing demands, the FAA considers all aviation airspace requirements in relation to airport operations, Federal Airways, Jet Routes, military flight training activities, and other special needs to determine how the National Airspace System can best be structured to satisfy all user requirements.

3.14.1 Description of Airspace Types

The FAA has designated four types of airspace above the United States: controlled, uncontrolled, special use, and other. A description of each type of airspace is as follows:

- *Controlled airspace* is categorized into five separate classes: Class A, B, C, D, and E airspace. These classes identify airspace that is controlled, airspace supporting airport operations, and designated airways affording en route transit from place-to-place. The classes also dictate pilot qualification requirements, rules of flight that must be followed, and the type of equipment necessary to operate within that airspace.
- *Uncontrolled* airspace is designated Class G airspace and has no specific prohibitions associated with its use. Class G airspace includes all airspace not otherwise designated as A, B, C, D, or E. Operations within Class G airspace are governed by the principle of "see and avoid."
- *Special Use Airspace* is designated airspace in which flight activities are conducted that require confinement of participating aircraft or that place operating limitations on nonparticipating aircraft. Restricted Areas, Military Operating Areas, and Warning Areas are examples of SUA. Warning Areas may contain hazards to nonparticipating aircraft in international airspace. Warning Areas are established beyond the 5.6 km (3 NM) limit. Since the U.S. territorial limit was extended to 22.2 km (12 NM) in 1988, Special Federal Aviation Regulation 53 establishes certain regulatory Warning Areas within the new 5.6 to 22.2 km (3 to 12 NM) territorial airspace to allow continuation of military activities while further regulatory requirements are determined.
- *Other airspace* consists of advisory areas, areas that have specific flight limitations or designated prohibitions, areas designated for parachute jump operations, Military Training Routes, and Aerial Refueling Tracks. This category also includes Air Traffic Control Assigned Airspace (ATCAA). When not required for other needs, ATCAA is airspace authorized for military use by the managing Air Route Traffic Control Center (ARTCC), usually to extend the vertical boundary of SUA.

3.14.2 Occurrence of Airspace

AFAST active sonar activities involving flight operations will generally occur in special use Warning Areas, which are plotted on aeronautical charts so all pilots are aware of their location and the potential for military flight training in the respective airspace. The airspace between and adjacent to the Warning Areas is designated as ATCAA. The FAA ARTCCs are responsible for air traffic flow control or management within this airspace transition. There are currently 22 ARTCCs in the United States (FAA, 2007). Within the AFAST Study Area, ARTCCs are located in New Hampshire, Virginia, and Florida (FAA, 2007).

The following sections describe the management of the Warning Areas within the AFAST Study Area.

3.14.2.1 Atlantic Ocean, Offshore of the Southeastern United States

The VACAPES OPAREA is a major area of military usage. The DoD has used the area extensively for military and National Aeronautics and Space Administration (NASA) training, testing, and ordnance and rocket firing exercises. The Fleet Air Control Surveillance Facility (FACSFAC) VACAPES provides fleet surveillance and functional area support services that include scheduling, monitoring, and controlling air traffic from just south of Nantucket Island, Massachusetts, to Charleston, South Carolina, and eastward more than 371 km (200 NM) into the Atlantic Ocean. The FACSFAC VACAPES reports to the Commander, Fleet Forces Command, via the Commander, Naval Air Forces Atlantic.

NASA's Goddard Space Flight Center, Wallops Flight Facility, is located on Wallops Island, Virginia. Launch activities can occur at the facility Monday through Friday, 6:00 AM to 6:00 PM (NASA, 2007a; 2007b). The Wallops Restricted Area (R-6604) connects Wallops with the Mid-Atlantic Test Range Warning Area. Because of their location, air traffic is minimal; however, when a mission requires additional airspace, NASA will coordinate with FACSFAC VACAPES (NASA, 2007b).

The CHPT OPAREA overlaps Warning Area 122 (W-122). This area is designated as SUA, which is managed by FACSFAC VACAPES.

The JAX OPAREA overlaps W-157, W-158, and W-159. These areas are designated as SUA, which is managed by FACSFAC JAX. FACSFAC JAX has responsibility for the OPAREA and Warning Areas from Charleston, South Carolina, to Daytona Beach, Florida, and is a subordinate command of Commander, Naval Air Force, U.S. Atlantic Fleet. The FACSFAC JAX is assigned additional duties by Commander, Navy Region Southeast. The CHASN OPAREA overlaps W-132, W-133, W-134, W-74, W-161, and W-177. These areas are designated as SUA and are managed by FACSFAC JAX.

3.14.2.2 Atlantic Ocean, Offshore of the Northeastern United States

The Narragansett Bay OPAREA overlaps W-105 and W-106. Both of these Warning Areas are designated as SUA. The airspace is managed by FACSFAC VACAPES.

3.14.2.3 Eastern Gulf of Mexico

FACSFAC Pensacola, which is a branch of the Air Traffic Control Facility at Pensacola Naval Air Station (NAS), is responsible for scheduling, coordinating, and monitoring airspace near W-155 and five ATCAAs adjacent to W-155. However, W-151, where torpedo exercises (TORPEX) activities will occur, is scheduled through the 46th Test Wing at Eglin AFB, Florida. FACSFAC Pensacola is responsible for coordinating naval airspace requests with Eglin AFB.

3.14.2.4 Western Gulf of Mexico

W-228, located off the coast of Corpus Christi NAS in Texas, supports the Chief of Naval Air Training, units of the Texas Air National Guard, and NASA aircraft from the Johnson Space Center. However, W-228 is primarily used for student pilot and navigator training. To emphasize the training mission, the airspace is considered "exclusive." Use of W-228 is augmented by use of Alert Area 632A. A-632A is not "exclusive" and not restricted on nonparticipants; however, the designation of this airspace allows nonparticipating pilots to recognize the high density aircraft, oftentimes engaged in training operations. NAS Corpus Christi coordinates military usage of the area.

3.15 ENERGY (WATER, WIND, OIL, AND GAS)

3.15.1 Water Energy

Although the potential advantages for development in water energy have been recognized for many years dating back to the late 1700s, the industry has only recently begun to advance. Scientists have concluded that only 0.2 percent of ocean energy could supply power to the world, yet the potential remains significantly undeveloped (Renewable Energy, 2007). Three types of ocean-wind energy exist: tidal, wave, and ocean thermal energy conversion.

Tidal energy requires extreme differences in tidal states while thermal conversion requires tropical weather. Therefore, these two developments are limited primarily to Maine and Alaska, where great differences in tides occur, and to Hawaii and the U.S. Atlantic Southeast, both of which possess a more tropical climate (California Energy Commission, 2007). Wave energy has a more general, universal application and has the possibility to generate up to 40 times more power than windmills with similar gear. Water possesses 1,000 times more energy density as compared with wind (Davidson, 2007; Pernick, 2005). Therefore, the required equipment and the potentially associated construction costs would be smaller than wind farms.

Wave-generated energy would be underwater or just above the ocean's surface (Pernick, 2005). Unlike wind and solar energy, waves, tides, and currents provide predictable and dependable potential sources (Andrews and Jelley, 2007). The types of equipment developed for ocean energy exploration range from buoys that convert bobbing of the waves into high-pressure flow to rotating turbines coupled with generators that turn the motion into energy. Some designs such as the more complex turbine require anchors or other attachment methods to the sea floor while others such as the buoys drift passively in the ocean (Pernick, 2005).

The first large-scale wave-generated project was established in Scotland off the Island of Islay in November 2000. The Land Installed Marine Powered Energy Transformer (LIMPET) generates approximately 500 kilowatt (kW) of energy, which is sufficient to support 400 homes (Environment News Service [ENS], 2000). Other countries that have recently tapped into this potential energy source include nations with long coastlines such as Great Britain and Australia (Andrews and Jelley, 2007).

The Federal Energy Regulatory Commission (FERC) has permitted 19 preliminary sites to study the potential of underwater turbine energy. Most of the areas are located off of Florida, San Francisco, California, and the Olympic peninsula in Washington state. Various companies are seeking permits for approximately 35 sites to study the potential for water-generated energy over a 36 month period (Burnham, 2007).

Studies have estimated that the amount of energy available in U.S. ocean waters is 9 to 10 times the potential generated by all hydroelectric dams. The potential generation of energy from coastal and ocean waters in the United States is higher on the west coast where waves are greater (Pernick, 2005).

3.15.1.1 Atlantic Ocean, Offshore of the Southeastern United States

The Gulf Stream has been identified as an area where water movement could provide advantageous conditions for the development of offshore water energy. Current and projected future developments in the southeastern United States include the development and improvement of infrastructure offshore of Dania Beach, Florida, near Fort Lauderdale by Ocean Renewable Power Company, Limited Liability Company (LLC) (Ocean Renewable Power Company, 2007). A submersible platform is being designed and built for support of the required equipment and will be anchored by an underwater mooring system. The platform and module to harness the power will be installed off Dania Beach, Florida, at the western edge of the Florida Current (Ocean Renewable Power Company, 2007). Once the 12 month monitoring period has concluded, the system will be improved and final design and installation will take place. This refinement will allow for future developments in deep waters. Additional sites have been identified in Miami, Florida, and West Palm Beach, Florida (Ocean Renewable Power Company, 2007).

3.15.1.2 Atlantic Ocean, Offshore of the Northeastern United States

Western Passage Project Adjacent to Eastport, Maine ORPC and the city of Eastport, Maine entered into a Memorandum of Understanding (MOU) to develop two tidal energy sites off the city's coast. This area, known as the Western Passage, was determined to have high tidal power potential. The system proposed is similar to the Dania Beach, Florida, infrastructure, which was described previously. ORPC has submitted the applications for preliminary permits to the FERC. A plan has been initiated to connect to the electrical grid in Maine (OPRC, 2007). OPRC is coordinating more studies to find additional sites with potential for tidal power in the state.

A number of sites have been proposed by a handful of companies as potential areas where waves and tides could be harnessed for energy generation. These locations include Piscataqua River (between Maine and New Hampshire); Merrimack River, Massachusetts; Amesbury, Massachusetts; and Indian River Inlet, Delaware. These sites are in various stages of preliminary test development and have been submitted for consideration by the FERC in the permitting process.

3.15.1.3 Eastern Gulf of Mexico

There are currently no proposed wave or tidal energy activities in this area.

3.15.1.4 Western Gulf of Mexico

There are currently no proposed wave or tidal energy activities in this area.

3.15.2 Wind-Based Energy

Wind, when harvested by wind turbines, can be used to generate electricity (Energy Information Administration, 2007). Private financial and investment firms supported the first wind farms, which U.S. aerospace and construction companies built in California in the early 1980s. Since then, installed capacity (or, how much power installed wind projects produce) has grown fivefold. Today, U.S. wind energy installations produce enough electricity on a typical day to power the equivalent of over 2.5 million homes (Department of Energy [DOE], 2007a). Overall, however, wind-based electricity represents a small percentage of the total electric capacity (or the maximum amount of energy that can be produced, measured in kilowatts).

In 1986 Pacific Northwest Laboratory estimated wind resources for the DOE. This assessment identified areas that were potentially suitable for wind energy applications. These areas were classified as having poor, marginal, fair, good, excellent, or outstanding wind resource potential (Elliott et al., 1986). Wind resource potential is linked to regions with topographic indicators (surface features) such as exposed coastal sites with strong upper-air winds or strong thermal/pressure gradients. In general, the assessment identified the exposed northeastern coastal areas from Maine to North Carolina and the Texas coastal area as having wind resource potential (Elliott et al., 1986).

3.15.2.1 Atlantic Ocean, Offshore of the Southeastern United States

Due to the relative flatness of the southeastern U.S. coastal plain from Florida to South Carolina, little potential exists to use wind as an energy source (Elliot et al., 1986). However, based on some of the more mountainous terrain of North Carolina and Virginia, some wind resource potential exists within these two states (Elliot et al., 1986). Winergy Power LLC (Winergy), a company that develops offshore wind energy, proposed the construction of 271 windmills offshore of Eastern Virginia in 2003. Since that time, the company has reduced the project significantly to encompass only 10 turbines after NASA and the Navy objected to the proposed locations and environmentalists objected to the potential effects to migratory birds and waterfowl (Virginia Department of Environmental Quality, 2007). Subsequently, Winergy has abandoned this proposal, and no other wind proposals exist for the state of Virginia waters. However, new research suggests that wind resources along the mid-Atlantic coast could provide a significant amount of energy to over nine states in the eastern United States; as such, the possibility for future construction of offshore windmills in this area exists (University of Delaware, 2007).

3.15.2.2 Atlantic Ocean, Offshore of the Northeastern United States

The wind resource potential along the coastal areas of the northeastern United States is categorized as good to outstanding. Specifically, good wind resource potential encompasses the exposed coastal areas and offshore islands and outstanding wind resource potential includes the outer capes and islands, including Cape Cod and Nantucket Island (Elliot et al., 1986). Based on these characteristics, three proposals have been made to develop wind energy in the northeast. They include projects in Buzzards Bay (located in the state waters of Massachusetts); Nantucket Sound (located in the territorial waters offshore of Massachusetts); and Long Island Sound (located in the territorial waters offshore of New York). Of these projects, MMS would regulate the Nantucket and Long Island projects while the State of Massachusetts would regulate the

Buzzards Bay wind farm. Each of these projects is currently undergoing project evaluation and environmental analysis (Patriot Renewables, 2006; MMS, 2007d, 2007e).

3.15.2.3 Eastern Gulf of Mexico

The coastal areas around Florida have a marginal wind resource potential as with the rest of the eastern and central GOMEX states (Elliot et al., 1986). This is most likely due to the relative flatness of the region. Based on these characteristics, no companies have included the eastern and central gulf in proposals for future wind generation projects.

3.15.2.4 Western Gulf of Mexico

The Texas coast in the GOMEX is estimated to have a fair wind resource potential (Elliot et al., 1986). Given this potential and the support in communities for the energy industry in general, two companies have proposed offshore wind farm projects in waters offshore of the Texas coast. They include a 150 MW wind farm located about 11 km (5.9 NM) off of Galveston Island, Texas and a 500 MW wind farm located between 4 and 13 km (2.2 and 7 NM) off the coast of Padre Island (DOE, 2005; Texas General Land Office [TGLO], 2005; Washington Post, 2006). MMS would regulate the proposal submitted by Galveston-Offshore Wind, LLC, while the State of Texas would regulate the proposal submitted by Superior Renewable Energy, LLC. The 30-year lease at the Galveston site would include 50 turbines over approximately 46 km^2 (18 mi^2). This site would produce electricity equivalent to the amount of energy produced by 20.7 million barrels of oil (TGLO, 2005). The wind farm off of Padre Island is expected to have more than 100 turbines over 161 km^2 (62 mi^2) and would generate the energy equivalent to burning 69 million barrels of oil. An EIS for this particular project is currently being developed (Washington Post, 2006).

3.15.3 Oil and Gas Exploration

MMS recently completed an assessment of the crude oil, natural gas liquids, and natural gas resources of the outer continental shelf. The assessment reflects data and information available as of 1 January 2003 (MMS, 2006b). The amounts in Table 3-18 reflect the average of the 95 percent and 5 percent probability of the estimated amounts being present. The table presents undiscovered technically recoverable resources (UTRRs), which is oil and/or gas that can be produced as a consequence of natural pressure, artificial lift, pressure maintenance, or other secondary recovery methods. UTRRs do not consider economic viability. In addition, the table presents undiscovered economically recoverable resources (UERRs), which is the portion of the undiscovered conventionally recoverable resources that is economically recoverable under imposed economic and technologic conditions. Table 3-13 presents three discrete oil/gas price pairs.

Table 3-13. Undiscovered Technically and Economically Recoverable Resources of Outer Continental Shelf Planning Areas

Region	UTRR		UERR					
	Oil (Bbo)	Gas (Tcfg)	$46/Bbl $6.96/Mcf		$60/Bbl $9.07/Mcf		$80/Bbl $12.10/Mcf	
			Oil (Bbo)	Gas (Tcfg)	Oil (Bbo)	Gas (Tcfg)	Oil (Bbo)	Gas (Tcfg)
Northeastern Atlantic Coast	1.91	17.99	1.15	6.91	1.32	8.65	1.45	10.32
Southeastern Atlantic Coast	1.91	18.99	1.08	6.79	1.24	8.64	1.39	10.43
Western GOMEX	10.70	66.25	8.69	51.86	9.25	56.47	9.71	59.87
Eastern GOMEX	34.2	166.28	27.08	110.96	28.93	128.3	30.49	141.67

Source: MMS, 2006c
Bbl = barrel; Bbo = billion barrels of oil; Mcf = thousand cubic feet; Tcfg = trillion cubic feet of gas; UERR = undiscovered economically recoverable resources; UTRR = undiscovered technically recoverable resources

3.15.4 Proposed Final Program for the Outer Continental Shelf Oil and Gas Leasing Program 2007-2012

MMS developed a Proposed Final Program for the Outer Continental Shelf Oil and Gas Leasing Program 2007-2012. The outer continental shelf is the submerged lands ranging anywhere from 4.8 to 321.9 km (2.6 to 173.7 NM) seaward of the state coastline.

The Proposed Final Program was prepared in accordance with the Outer Continental Shelf Lands Act, which requires the preparation of an oil and gas leasing program indicating a five-year schedule of lease sales designed to best meet the nation’s energy needs. The Proposed Final Program is the first in a series of leasing proposals developed for public review before the Secretary of the Interior can take final action to approve the new five-year program for 2007-2012 (MMS, 2007h). The current five-year program ended on 30 June 2007. A summary of options proposed for the East Coast and GOMEX are provided below.

3.15.4.1 Atlantic Ocean, Offshore of the Southeastern United States

Four sales have been held between 1978 and 1983, and there were six exploratory wells drilled in the southern Atlantic (South Carolina, Georgia, and Florida) area, with no commercial discoveries. There are no existing leases, and this area has been under annual congressional restrictions since 1990 and will be under presidential withdrawal through 2012 (MMS, 2006d).

Three options are presented in the Proposed Final Program for the coastline of Virginia. The first option involves one special interest sale (in 2011), including a 40 km (22 NM) buffer and a no-obstruction zone from the mouth of the Chesapeake Bay off the coastline of Virginia. The second option invoves one special interest sale (in 2011), but with a 80 km (43 NM) buffer and a no-obstruction zone from the mouth of the Chesapeake Bay off the coastline of Virginia. The third option was considered a no sale (MMS, 2007h). The Draft Proposed Program is not proposing any area along the South Carolina, Georgia, or Florida coastlines for leasing consideration.

3.15.4.2 Atlantic Ocean, Offshore of the Northeastern United States

One lease sale was held in 1979, and there were eight exploratory wells drilled with no commercial discoveries. There are no existing leases, and this area has been under annual congressional restrictions since 1984 and will be under presidential withdrawal through June 2012 (MMS, 2007h). The Proposed Final Program is not proposing any area along the Atlantic Ocean for leasing consideration.

3.15.4.3 Gulf of Mexico

There are three planning areas in the GOMEX Region: Western, Central, and Eastern GOMEX. The Western and Central areas constitute the most active areas of the outer continental shelf program. The majority of the Eastern Gulf Planning Area is currently under presidential withdrawal and is subject to annual congressional moratoria, with the exception of the area identified as Sale 181. Much of the Sale 181 area is now in the Central Gulf Planning Area (MMS, 2007h).

The GOMEX Energy Security Act of 2006 opened 2,347.2 km^2 (684.3 NM^2; 580,000 acres) of the Eastern GOMEX Planning Area (Figure 3-6) for oil and gas leasing (MMS, 2006d). Specifically, the Act mandated leasing options for two areas: the Eastern GOMEX Planning Area and the Central GOMEX Planning Area. The Eastern GOMEX Planning Area allows for oil and gas leasing in two areas: “181 Area,” which comprises 8,093.7 km^2 (2,359.7 NM^2; 2 million acres) in the Central GOMEX Planning Area and approximately 2,347.2 km^2 (684.3 NM^2; 580,000 acres) in the Eastern GOMEX Planning Area. The second area, “181 South Area,” is located in the Central GOMEX Planning Area south of the “181 Area” and is approximately 23,471.8 km^2 (6,843.3 NM^2; 5.8 million acres). These leasing opportunities are located west of the Military Mission Line. The military practices aerial maneuvers and bombing trials east of the Military Mission Line (National Ocean Industry Association [NOIA], 2006). The Central GOMEX portion of the 181 Area will be available for lease in Sale 205 scheduled for early fall of 2007 (MMS, 2006d).

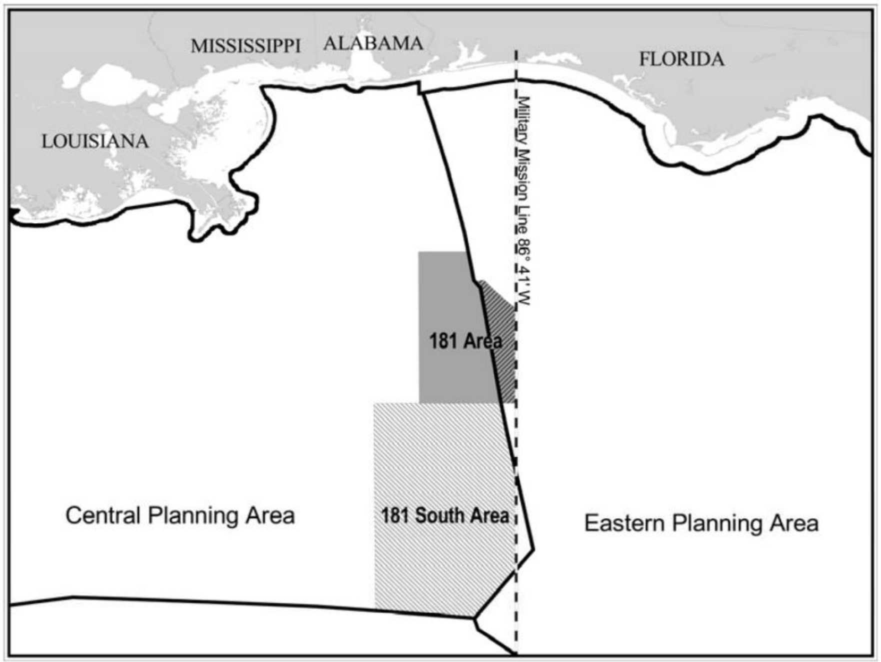


Figure 3-6. Eastern GOMEX Planning Area
Source: MMS, 2006c

One option discussed in the 2007 Final Proposed Program would continue the policy of holding area-wide annual sales in one of the two areas with the most resources and highest values. Two whole and portions of other blocks within the boundary of the Flower Garden Banks National Marine Sanctuary are excluded from the area available for leasing (MMS, 2007h).

3.16 RECREATIONAL BOATING

3.16.1 Atlantic Ocean, Offshore of the Southeastern United States

Recreational activities offshore of Virginia's coast are primarily composed of game and sport fishing, charter boat fishing, sport diving, whale watching, sailing, power cruising, and other recreational boating activities. Five artificial reefs are located offshore of the Virginia coast. Three of these offshore artificial reefs (Blackfish Bank, Parramore Reef, and Wachapreague Reef) are located north of the mouth of Chesapeake Bay (DON, 2005).

The waters and coastal areas around the CHPT Range Complex are popular for sport fishing, diving, shipwreck exploration, and other recreational activities (e.g., boating or kayaking). Navy operations and recreational ocean activities have coexisted in the Navy Cherry Point Range Complex for decades. The Navy's public safety and mitigation measures, such as advance notification of scheduled activities, minimize inconveniences to public interests and help ensure the continued safe and cooperative coexistence (DON, 2008n).

The primary recreational activities along the east coast of Florida include game and sport fishing, charter boat fishing, sport diving, sailing, power cruising, and other recreational boating activities. Recreational fishing and other recreational boats travel throughout the coastal waters and during all four seasons. Many sites that are known as fishing hotspots attract divers. Fishing hotspots and other dive sites (including artificial reefs, coral patches, and shipwrecks) are used throughout the year by recreational vessels and commercial chartered boats, but use is highest during the summer.

3.16.2 Atlantic Ocean, Offshore of the Northeastern United States

Within the northeastern AFAST Study Area, recreational boating activities mainly include game and sport fishing, charter boat fishing, sport diving, whale watching, sailing, power cruising, and of other such recreational boating activities. Boating off the northeastern Atlantic coast takes place from Maine to Maryland. Many sites that are known as fishing hotspots attract divers. These fishing hotspots and other dive sites (including artificial reefs and shipwrecks) are used throughout the year by recreational vessels, but use is highest during the summer. Most recreational boating occurs within a few miles of shore, while U.S. naval operations normally occur far offshore. The Navy would typically conduct these exercises in federal waters not in inshore state waters near recreational boaters.

3.16.3 Eastern Gulf of Mexico

Recreational boating activities in the eastern GOMEX are primarily associated with sport fishing, charter boat fishing, sport diving, sailing, power cruising, and other recreational boating activities. Recreational fishing boats and other recreational boats range throughout coastal waters in the northeast GOMEX, depending on the season and weather conditions. Most recreational fishing and boating occurs within a few miles of shore, with boats generally returning to the point of departure. Fishing charters and recreational fishing boats pursuing sport fishing opportunities in deeper water can be expected to traverse the eastern GOMEX. Fishing parties may also enter the eastern GOMEX to fish at artificial reefs. Numerous artificial reefs have been established along the coast of the northeastern Gulf, many of them at considerable distances from shore (DON, 2007d).

3.16.4 Western Gulf of Mexico

The 590.6 km (367 mi) of Texas Gulf Coast shoreline, along with the 5,310.8 km (2,867.6 NM) of bay-estuary-lagoon shoreline, make the coastal region a popular place for a variety of recreational activities including boating, fishing, and bird watching. Approximately 621,000 boats were registered in Texas in 2005, placing the state fifth in the country (Texas Parks and Wildlife Department [TPWD], 2006b).

3.17 COMMERCIAL AND RECREATIONAL FISHING

3.17.1 Commercial Fishing

Data were collected on commercial fisheries landings, fishing gear used, fishing effort, and known fishing hotspots.

3.17.1.1 Atlantic Ocean, Offshore of the Southeastern United States

3.17.1.1.1 Landings

Between 1996 and 2006, the commercial landings of food and baitfish in the southeast, measured by weight, averaged about 323.3 million kg (712.8 million lb). Commercial landings peaked in 1996 at almost 424.9.4 million kg (936.8 million lb). The lowest landings occurred 10 years later in 2006, when commercial fisherman landed about 244.9 million kg (539.9 million lb) of finfish and shellfish (NMFS, 2007c).

The dollar values of the landings averaged approximately $304 million over the decade. The total values ranged from a low of about $258 million in 2006 to a high of over $338 million in 2000. Landings by weight decreased by more than 42 percent over the decade, and on average, landings by value decreased by 20 percent (NMFS, 2007c).

During 2006, Virginia, North Carolina, and Florida were the top three states in terms of overall commercial landings by weight and total value of commercial landings in the southeast. Commercial landings in Virginia accounted for nearly 79 percent of the total commercial landings measured by weight in the southeast, followed by North Carolina accounting for nearly 13 percent, and Florida accounting for nearly 5 percent. In terms of total value of commercial landings in the southeast, Virginia accounted for 43 percent, North Carolina accounted for 28 percent, and Florida accounted for 16 percent (NMFS, 2007c).

Atlantic menhaden was the dominant species by weight in the southeast, and blue crab was the second most dominant species. With landings of about 169.2 million kg (373 million lb), Atlantic menhaden comprised 69 percent of the total landings in the southeast in 2006. Blue crab comprised 11 percent of the total landing, with landings of approximately 57 million pounds (NMFS, 2007d).

By weight, over 51 percent of the landings in the southeast in 2006 were from state waters; approximately 49 percent were from federal waters. However, by financial value, landings from state waters accounted for 47 percent of the total value of the southeast marine fisheries, whereas landings from federal waters amounted to 53 percent (NMFS, 2007e).

Finfish dominated the catches in southeast state waters in 2006, representing approximately 73 percent of the catch by weight. Shellfish comprised just over 27 percent of the catch. However, in terms of value, finfish accounted for approximately 32 percent, and shellfish comprised over 68 percent of the total value of the landings in southeast state waters (NMFS, 2007e).

Similar to state waters, the majority of the catch in federal waters by weight was finfish, and shellfish accounted for a larger share of the value of the southeast Commercial fishery landings. By weight, 93 percent of the landings from federal waters were finfish, and 7 percent were shellfish. However, when measured by value, shellfish accounted for over 56 percent of the total landings, while finfish accounted for nearly 44 percent (NMFS, 2007e).

3.17.1.1.2 Fishing Gear and Fishing Effort

Purse seines were the principal gear used to harvest marine fishery resources (including menhaden) in the southeast during 2006. They accounted for nearly 68 percent of the total commercial landings for the southeast in pounds and eight percent of the total value of all commercial landings in the southeast. Otter trawls were also highly used, and landings caught by all types of otter trawls (i.e., crab, fish, scallop, and shrimp) combined accounted for over 21 percent of the total value of all commercial landings in the southeast (NMFS, 2007f).

3.17.1.2 Atlantic Ocean, Offshore of the Northeastern United States

3.17.1.2.1 Landings

Between 1996 and 2006, the commercial landings of food and baitfish in the Northeast, measured by weight, averaged over 419 million kg (924 million lb). Commercial landings peaked in 2004 at over 450 million kg (992 million lb). The lowest landings occurred four years before the peak, when commercial fisherman landed about 386 million kg (850 million lb) of finfish and shellfish (NMFS, 2007c).

The dollar values of the landings averaged almost $953 million over the decade. Total values ranged from a low of over $786 million in 1998, to a high of over $1,256 million seven years later in 2005. Although landings by weight decreased by 3 percent over the entire decade, total value of landings increased by almost 50 percent (NMFS, 2007c).

Atlantic herring was the dominant species by weight in the northeast area, and Atlantic mackerel was the second most dominant species. With landings of over 93 million kg (206 million lb), Atlantic herring comprised almost 22 percent of the total landings in this area in 2006. Atlantic mackerel comprised over 13 percent of the total landings, with a commercial catch amount of approximately 57 million kg (125 million lb) (NMFS, 2007d).

By weight, about 34 percent of the landings along the northeast Atlantic coast in 2006 were from state waters; approximately 67 percent were from federal waters. However, by value, landings from state waters and federal waters were closer by percentage, with 47 percent of the total value of the northeast marine fisheries coming from state waters, whereas landings from federal waters amounted to approximately 53 percent (NMFS, 2007e).

In 2006 shellfish dominated the catches, by weight, in state waters of the northeastern OPAREAs, representing approximately 58 percent. Finfish comprised nearly 42 percent of the catch. In terms of value, finfish accounted for only 8 percent, and shellfish comprised approximately 92 percent of the total value of the landings in northeast state waters (NMFS, 2007e).

The majority of the catch in federal waters, by weight, was finfish at about 71 percent, while shellfish represented 29 percent. However, shellfish accounted for 71 percent of the total value of landings in federal waters, whereas finfish accounted for over 29 percent of the value of landings here (NMFS, 2007e).

3.17.1.2.2 Fishing Gear and Fishing Effort

Trawls were the principal gear used to harvest marine fishery resources in the northeast during 2006. Commercial operations use trawls to catch various types of species on the bottom and in the middle of the water column; those species include the following: northeast groundfish, monk fish, skates, spiny dog fish, clams, Atlantic herring, American lobster, northern shrimp, and winter trawl. Trawls accounted for nearly 47 percent of the total commercial landings (in pounds) for the region and 14 percent of the total value of all commercial landings (NMFS, 2007f). Dredges and pots/traps were also highly used, and those landings caught by all types of dredges combined and by pots/traps accounted for over 32 percent and 35 percent of the total value of all commercial landings, respectively (NMFS 2007k).

3.17.1.3 Eastern Gulf of Mexico

3.17.1.3.1 Landings

Between 1996 and 2006, the commercial landings of food and baitfish off the eastern GOMEX measured, by weight, averaged about 142 million kg (313 million lb). Commercial landings ranged between a high of nearly 172 million kg (382 million lb) in 1999 to a low of approximately 119 million kg (262 million lb) seven years later in 2005 (NMFS, 2007c).

The total value of all commercial landings off the eastern GOMEX averaged about $237 million. over the decade. Values ranged from a high of $280 million in 2000 to a low of approximately $199 million in 2005. Landings by weight increased 15 percent over the decade, however total value of landings decreased by nearly 8 percent (NMFS, 2007c).

Menhaden was the dominant species of commercial landings by weight in 2006, accounting for close to 65 percent of the total landings in the eastern GOMEX, landing over 96 million kg (211 million lbs). Shrimp species, such as brown, pink, white, and rock shrimp, were the second most dominant species landing around 44 million kg (50 million lbs), representing approximately 15 percent by weight of the total landings (NMFS, 2007d).

By weight, 82 percent of the landings in the eastern GOMEX were from state waters; approximately 18 percent were from federal waters. Landings from state waters also accounted for 53 percent of the total value of the marine fisheries in the eastern GOMEX. The total value of landings from federal waters amounted to more than 47 percent (NMFS, 2007e).

In 2006, finfish dominated the catches in state waters in the eastern GOMEX, representing approximately 86 percent of the landings by weight. Shellfish comprised just 14 percent of the catch. Although there were more finfish landings in state waters according to weight, shellfish accounted for the majority of the value. Shellfish accounted for over 83 percent of the total value of the landings in state waters in the eastern GOMEX, while finfish only accounted for 17 percent (NMFS, 2007e).

Shellfish represented the majority of the catch in federal waters. By weight, 58 percent of the landings from federal waters were shellfish, and 42 percent were finfish. Shellfish also comprised the majority of the landings by value, with 65 percent, while finfish accounted for the remaining 35 percent (NMFS, 2007e).

3.17.1.3.2 Fishing Gear and Fishing Effort

Purse seines for catching menhaden were the principal gear in the eastern GOMEX during 2006. They accounted for nearly 65 percent of the commercial landings by weight for the eastern GOMEX region, but only four percent of the total value of commercial landings. Otter trawls were second, accounting for over 15 percent of the commercial landings by weight and 38 percent of the total value of the landings. Pots and traps were also highly used, while only accounting for over five percent of the commercial landings by weight, they accounted for over 16 percent of the total value of commercial landings in the eastern GOMEX region (NMFS, 2007f)

3.17.1.4 Western Gulf of Mexico

3.17.1.4.1 Landings

The total commercial landings in the western GOMEX between 1996 and 2006, measured by weight, averaged 583 million kg (1,286 million lb). Commercial landings ranged from a high of 730 million kg (1,609 million lbs) in 1999, to a low of 423 million kg (932 million lbs) seven years later in 2005 (NMFS, 2007c).

The total value of all commercial landings in the western GOMEX averaged about $506 million over the decade. Values ranged from a high of $710 million in 2000 to a low of approximately $423 million in 2005. Landings by weight decreased 1 percent over the decade, and total value of landings decreased by only 1 percent (NMFS, 2007c).

Menhaden was the dominant species of commercial landings by weight in 2006, accounting for over 67 percent of the total landings in the western GOMEX, landing nearly 313 million kg (690 million lbs). White shrimp were the second most dominant species landing close to 54 million kg (119 million lbs), representing approximately 12 percent by weight of the total landings (NMFS, 2007d).

By weight, 44 percent of the landings in the western GOMEX were from state waters; approximately 56 percent were from federal waters. However, landings from state waters accounted for 55 percent of the total value of the marine fisheries in the western GOMEX, whereas, the total value of landings from federal waters amounted to nearly 45 percent (NMFS, 2007e).

In 2006, finfish dominated the catches in state waters in the western GOMEX, representing over 60 percent of the landings by weight. Shellfish comprised 40 percent of the catch. Although there were more finfish landings in state waters according to weight, shellfish accounted for the majority of the value. Shellfish accounted for approximately 92 percent of the total value of the landings in state waters in the western GOMEX, while finfish only accounted for 8 percent (NMFS, 2007e).

Finfish represented the majority of the catch in federal waters. By weight, 84 percent of the landings from federal waters were finfish, and nearly 16 percent were shellfish. Although there were more finfish landings in federal waters according to weight, shellfish accounted for the majority of the value. Shellfish accounted for 77 percent of the total value of commercial landings in federal waters in the western GOMEX, while finfish accounted for the remaining 23 percent (NMFS, 2007e).

3.17.1.4.2 Fishing Gear and Fishing Effort

Otter trawls were the principal gear used in the western GOMEX during 2006. They accounted for 18 percent of commercial landings by weight for the western GOMEX and over 55 percent of the total value. Pots and traps were second, accounting for over five percent of commercial landings by weight, and over seven percent of the total value of commercial landings in the western GOMEX. Dredges were also used, while accounting for only one percent of commercial landings by weight, they accounted for eight percent of the total value of commercial landings in the western GOMEX (NMFS 2007k).

3.17.2 Recreational Fishing

This section provides baseline recreational fishing information for areas located within the AFAST Study Area. Nationwide, recreational saltwater fishing generated over $30 billion in sales in 2000, nearly $12.0 billion in income, and supported nearly 350,000 jobs (Steinbeck et al., 2004).

3.17.2.1 Atlantic Ocean, Offshore of the Southeastern United States

Sportfishing has long been one of America's most popular recreational activities. Participation in the sport, nationwide, has grown nearly 10 percent in five years. In 2006, there were 13 million saltwater fishermen, 89 million fishing trips, 475 million fish caught, and 55 percent of fish caught were released. Florida is the most popular fishing state followed by North Carolina. Florida had more 6.7 million anglers and 29.3 million number of trips in 2006 while North Carolina had 2.2 million anglers.

3.17.2.1.1 Landings

Marine recreational catch off the coast of the southeastern United States, by weight, averaged approximately 111 million pound per year between 1996 and 2006. Recreational catch reached a period low of nearly 77 million in 1996 and a period high of almost 132 million in 2006 (NMFS, 2007c).

The majority of catches were from state waters followed by catches in federal waters and lastly, state territorial seas. Striped bass and Atlantic croaker were the most popular catch, according by weight, reported in state and state territorial waters in the southeast region. Other popular species included spots, bluefish, dolphin, black sea bass, and other tunas and mackerels.

3.17.2.1.2 Fishing Effort

The total number of anglers who participated in recreational marine fishing in the southeastern Atlantic regions in 2006 reached over 5.7 million. The total number of trips to state territorial seas, state waters, and federal waters combined totaled over 44 million trips in 2006, an increase of 7 percent from 2001. The majority of trips were made to state waters.

3.17.2.1.3 Tournaments in the Southeastern OPAREAs

Various organizations host recreational fishing tournaments throughout the year along the southeastern Atlantic coast from Virginia to Florida. The majority of tournaments take place during the weekends (Friday through Sunday) or from the middle of the week through the weekend (Wednesday to Sunday). The majority of fishing takes place at hotspots like canyons and humps. Along the Virginia coast, many of the same canyons (Washington Canyon, Poor Man's Canyon, Massey's Canyon, 26 Mile Hill, the Hot Dog, the Lumps, Lumpy Bottom, and the Boomerang) mentioned in the northeastern United States section below apply to Virginia. Other canyons that are fished but not mentioned in the northeastern United States section include Norfolk Canyon, 100 Fathom Curve, 30 Fathom Lumps, Cigar Hill, 21 Mile Hill, and the Parking Lot. Off the coast of North Carolina, South Carolina, Georgia, and some of Florida, such areas as Edisto Banks, Georgetown Hole, Sow Pen, the Deli, the Deep Water Wreck, Triple Ledge, the South Ledge, and the South Hump, are fished for the mentioned species. Similar to the northeastern Atlantic coast, species fished include blue fin tuna, yellow fin tuna, wahoo, dolphin, big eye tuna, white marlin, and blue marlin. All of these species are found in the above hotspots and are best fished during the spring and summer months. Fishing methods include trolling, still fishing, casting, drifting, and chunking.

A majority of the fishing tournaments that occur along the southeastern Atlantic coast last for a few days during the week, and a few tournaments last up to one week in the months of April, May, and June through August, with some occurring in September and October and continuing into December and January. Some examples of tournaments occurring of the coast of Florida include the Silver Sailfish Derby in Palm Beach; Pelican Yacht Club Annual Invitational Billfish Tournament in Fort Pierce; Palm Beach Sailfish Classic in Palm Beach Shores; Annual Bluewater Tournament in St. Augustine; Halifax Sport Fishing Club Billfish Blowout in Ponce Inlet; and Halifax Sport Fishing Club Annual Offshore Lady Anglers Tournament in Ponce Inlet. Some examples of tournaments occurring of the coast of Georgia include the Silverado Slam Tour, and the Savannah Sport Fishing Club Bluewater Tournament. Some examples of tournaments occurring of the coast of South Carolina include the Silverado Slam Tour, Edisto Marine Billfish Tournament, Annual Georgetown Blue Marlin Tournament, Fifty-Fifty Tournament, the Bohicket Marina Invitational Billfish Tournament, and the South Carolina Saltwater Sportfishing Association Sailfish Tournament. These events occur Sunday, Wednesday through Saturday, Wednesday through Saturday, Friday through Saturday, Wednesday through Saturday, and Thursday through Sunday, respectively. Some examples of tournaments occurring of the coast of North Carolina include the Hatteras Village Offshore Open, Big Rock Blue Marlin Tournament, Barta Boys and Girls Club Billfish Tournament, and Pirate's Cove Annual Billfish Tournament. Some examples of tournaments occurring of the coast of Virginia include the Virginia Beach Billfish Tournament, Virginia Beach Tuna Tournament, and the Annual Tuna-ment.

3.17.2.2 Atlantic Ocean, Offshore of the Northeastern United States

For the purposes of this study, seven states including: Maine, New Hampshire, Massachusetts, Connecticut, Rhode Island, New Jersey, and New York are considered part of the northeastern United States. Within these areas comprise Narragansett Bay Complex, Boston Complex, and the Atlantic City OPAREA. Within the vicinity of these OPAREAs, New Jersey and New York ranked as the third and fifth most popular saltwater fishing states in 2006, respectively. Recreational fishing in New York and New Jersey combined totaled more than $1.5 billion in economic output in 2001.

3.17.2.2.1 Landings

Marine recreational catch off the coast of the northeastern United States, by weight, averaged approximately 35.4 million kg (78 million lb) per year between 1995 and 2005. During the 10-year period, recreational catch reached a low of 22.2 million kg (49 million lb) in 1998 and a high of 42.1 million kg (92.8 million lb) in 2000.

Reported recreational catches in the state waters, state territorial seas, and federal waters in the northeast fluctuated between 1995 and 2005 but had an overall increase of 8 percent during the period. The majority of catches were from state waters that accounted for more than half of all recreational catch. Striped bass were the most prevalent recreational catch, according by weight, in state and state territorial waters off the coast of the Atlantic in the northeastern area in 2005. Striped bass catch totaled over 5.44 million kg (12 million lb) and accounted for over 15 percent of the total reported marine recreational catch in that year. The Atlantic cod was the most caught species in federal waters and accounted for only 3.5 percent of the total recreational catch in 2005.

3.17.2.2.2 Fishing Effort

The total number of anglers who participated in recreational marine fishing in the northeastern Atlantic in 2006 reached over 3.6 million. The total number of trips to state territorial seas, state waters, and federal waters combined totaled over 29 million trips in 2006, an increase of 4 percent from 2001. The majority of those trips were made to state waters.

3.17.2.2.3 Tournaments in the Northeastern OPAREAs

Recreational fishing tournaments occur throughout the year from Maine to New Jersey along the northeastern Atlantic coast. A large proportion of the activities take place during the weekend, beginning on Friday and ending on Saturday or Sunday. However, longer tournaments, which comprise the majority of the activities along the northeastern Atlantic coast, begin either Wednesday or Thursday and/or extend through the following Monday or Tuesday. The majority of fishing takes place at hotspots along canyons and humps, including such places as Baltimore Canyon, Poor Man's Canyon, Washington Canyon, the Hot Dog, Lumpy Bottom, the Lumps, Massey's Canyon, and the Boomerang. Species that are fished include blue fin tuna, yellow fin tuna, wahoo, dolphin, big eye tuna, white marlin, and blue marlin. All of these species are found in the above hotspots and are best fished during the summer months. Fishing methods include trolling, still fishing, casting, drifting, and chunking.

Most fishing tournaments in this area last for a few days in the months of June to August, but some extend to September and even into October. Tournaments include the following: 20th Annual Ocean City Tuna Tournament in Ocean City, Maryland; Mid-Atlantic $500,000 Tournament at South Jersey Marina in Cape May, New Jersey; Annual Giant Blue Fin Invitational Tournament at Hyannis Marina in Cape Cod, Massachusetts; and Annual Sturdivant Island Tuna Tournament at Spring Point Marina in South Portland, Maine. These activities occur

Wednesday to Sunday, Sunday to Friday, Thursday to Sunday, and Thursday to Saturday, respectively.

3.17.2.3 Eastern Gulf of Mexico (Florida)

Saltwater sportfishing in Florida provided a total economic output of more than $5.4 billion in 2001. Retail sales amounted to almost $3 billion, while the sport supported over 59,000 jobs and over $1.4 billion in wages and salaries. The total federal income taxes from saltwater fishing amounted to over $239.7 million (ASA, 2007a). Florida has been ranked the top state by overall economic output (ASA, 2007b), and moreover, has been ranked the top fishing destination among nonresidents. Over 1 million nonresident anglers provide more than $1.5 billion of the state's total economic output (ASA, 2007b).

3.17.2.3.1 Landings

The marine recreational catch in the Eastern GOMEX, averaged 44.7 million kg (98.6 million lb) per year between 1995 and 2005 in state territorial seas, state waters, and federal waters combined. During that period, catches reached a low in 2005 with about 34.2 million kg (75.4 million lb), a decrease from the high of nearly 46.86 million kg (103.3 million lb) caught in 1997.

Reported catch in state territorial seas, state waters, and federal waters have declined since 1995. In state territorial seas, catch declined by the largest amount, with a 35 percent decrease in pounds between 1995 and 2005, while catch declined by 10 percent in state waters and 32 percent in federal waters, by total weight (NMFS, 2007g).

Spotted sea trout represent the majority of species caught, according to weight, by marine recreational anglers in 2005 within state territorial seas and state waters. The spotted sea trout accounted for approximately 16 percent of catch in state waters, by weight, and 18 percent of catch in state territorial seas. The most caught species in federal waters was the mycteroperca grouper, a type of sea bass, which comprised nearly 24 percent of all catch in federal waters (NMFS, 2007g).

3.17.2.3.2 Fishing Effort

The total number of anglers who participated in recreational marine fishing in the eastern GOMEX in 2005 reached over 2.46 million, an increase of approximately 8 percent from 2000 estimates. The total number of trips to state territorial seas, state waters, and federal waters, combined, averaged over 15.7 million trips over the five-year period (2000-2005). The majority of those trips made were to state waters (NMFS, 2007g).

3.17.2.3.3 Tournaments

The three major fishing tournaments held each year in the eastern GOMEX include the following: Mobile Big Game Fishing Club Memorial Day Tournament in Orange Beach, Alabama; Bay Point Billfish Invitational Tournament in Panama City, Florida; and Orange Beach Billfish Classic in Orange Beach, Alabama. These events occur from Friday to Monday and from Friday to Sunday, respectively, and participants target popular fishing locations. The majority of fishing takes place on artificial reefs and at hotspots like canyons and humps. Species fished include blue fin tuna, yellow fin tuna, wahoo, dolphin, big eye tuna, white marlin, and blue marlin. All of these species are found along hotspots, artificial reefs, and open ocean during the summer months. The fishing tournaments mentioned above last for a few days in the months of May, June, July, and August. Fishing methods include trolling, still fishing, casting, drifting, and chunking.

3.17.2.4 Western Gulf of Mexico

Saltwater sportfishing in Texas provided a total economic output of more than $1.3 billion in 2001. Retail sales amounted to over $600 million, while the sport supported over 13,000 jobs and over $339.3 million in wages and salaries. Total federal income taxes from saltwater fishing amounted to over $55.6 million (ASA, 2007a). Texas has been ranked in the top states by overall economic output (ASA, 2007b).

3.17.2.4.1 Fishing Effort

Between 2000 and 2001, recreational anglers in Texas caught 2.5 million fish in the GOMEX. The American Sportfishing Association estimates the total economic value of recreational fishing in the GOMEX at $8 billion per year, while other estimates suggest the economic value of commercial fishing is only $692 million. However, this figure for commercial fishing does not include the value of the commercial fishing industry's total economic contribution such as employment and revenue generated from businesses, whereas estimates for recreational fishing generally do include these economic values (Staats, 2003). The daily recreational fishing effort and anglers' estimated willingness-to-pay (WTP) along the Gulf Coast states was highest in west Florida and lowest in Texas (Lynch and Harrington, 2003). The WTP is a measure often used to estimate the value of a resource that does not have a monetary value attached.

Recreational fishing occurs offshore of Port Isabel, Texas, in the vicinity of the OPAREA (Green et al., 2002). The species fished for include red snapper (*Lutjanus campechanus*), king mackerel (*Scomberomorus cavalla*), dolphin (*Coryphaena hippurus*), yellowfin tuna (*Thunnus albacares*), blackfin tuna (*Thunnus atlanticus*), cobia (*Rachycentron canadum*), wahoo (*Acanthocybium solanderi*), shark (various species), amberjack (*Serioloa dumerili*) and vermilion snapper (*Rhombloplites aurorubens*).

3.17.2.4.2 Tournaments

Major fishing tournaments in the western GOMEX occur from Venice, Louisiana, to South Padre Island, Texas. The majority of the events in the region generally run from the middle of the week through the weekend (Wednesday through Sunday). The majority of fishing takes place on artificial reefs and at hotspots like canyons and humps. Similar to the eastern and central GOMEX, species fished in the western GOMEX include blue fin tuna, yellowfin tuna, wahoo, dolphin, big eye tuna, white marlin, and blue marlin. These species can be found along hotspots, artificial reefs, and the open ocean during summer months. Fishing methods include trolling, still fishing, casting, drifting, and chunking.

Four major fishing tournaments are known to occur in this area: Texas Legends Billfish Tournament in Port Arkansas, Texas; Texas International Fishing Tournament in South Padre

Island, Texas; Cajun Canyons Billfish Classic in Venice, Louisiana; and Houston Invitational Billfish Tournament in Galveston Yacht Basin, Texas. These activities occur Thursday to Sunday, Wednesday to Sunday, Thursday to Sunday, and Thursday to Saturday, respectively.

3.18 COMMERCIAL SHIPPING

3.18.1 Atlantic Ocean, Offshore of the Southeastern United States

The waters off the U.S. Atlantic coast support a large volume of maritime traffic heading to and from foreign ports, as well as traveling north and south to various U.S. ports. Commercial shipping makes up a large portion of this traffic, and a number of commercial ports are located along the southeastern U.S. coast.

The VACAPES OPAREA is in the direct path of commercial ship traffic traveling between the major ports of New York and Boston along the northeastern seaboard and Miami and other ports in the southeast (Figure 3-7). There are several major shipping lanes in the VACAPES OPAREA. Most of the lanes are oriented roughly parallel to the coastline, but two major lanes split into two additional lanes once they are beyond the shore. It is very likely that commercial ship traffic would be present in nearly all parts of the OPAREA, with the exception of the southeastern-most section.

The CHPT OPAREA is in the direct path of commercial ship traffic traveling between the major ports of New York and Boston along the northeastern seaboard and Miami and other ports in the southeast (Figure 3-7). There are seven major shipping lanes in the CHPT OPAREA. Most of the lanes are oriented roughly parallel to the coastline, but several branch off the main routes. It is very likely that commercial ship traffic would be found in nearly all parts of the OPAREA.

The JAX/CHASN OPAREA is in the direct path of commercial ship traffic traveling between the major ports of New York and Boston along the northeastern seaboard and Miami and other ports in the southeast (Figure 3-7). Nearshore shipping lanes aid ocean-going vessels in avoiding navigational conflicts and collisions in areas leading into and out of major ports. Offshore, there are no designated shipping lanes; vessels generally follow routes determined by their destination, depth requirements, and weather conditions. It is very likely that commercial ship traffic would be found in nearly all parts of the OPAREA.

3.18.2 Atlantic Ocean, Offshore of the Northeastern United States

As shown in Figure 3-7, the northwestern Atlantic Ocean has some of the busiest shipping lanes in the world, and a large volume of ship traffic transits the Study Area. Maritime traffic includes ships traveling within New England and mid-Atlantic ports in the United States as well as traffic to eastern Canada and the eastern Atlantic Ocean. Commercial (domestic and international) shipping constitutes the vast majority of this traffic. One primary shipping lane in the Study Area is off northern New England with many arteries leading to ports in Massachusetts, New Hampshire, and Maine. The majority of the eastern portion of the Boston OPAREA is free from commercial traffic, but commercial traffic can be expected in the western part of the OPAREA. Several primary shipping lanes crisscross the Narragansett Bay OPAREA, leading to the major ports of New York City, New York, and Newark, New Jersey, as well as Providence, Rhode

Island. Similarly, the Atlantic City OPAREA contains several primary shipping lanes leading from New York City and Newark to ports in Delaware Bay and the mid-Atlantic United States. It is, therefore, highly likely that commercial ship traffic will be encountered throughout the greater part of all the northeastern OPAREAs.

Some of the largest ports in the United States are found in the vicinity of the northeastern OPAREAs. The port complex of New York City/Newark is ranked third in the United States, while New England's largest port, Boston, is ranked twenty-second in the United States, as determined by the Port Import/Export Reporting Service. The port complex of New York City/Newark has more scheduled services to a wider variety of trade lanes than any other port in North America. This port complex is the leading container volume gateway on the east coast. Since Halifax, Canada, is closer to northern Europe than any other major North American port, the complex is frequently used as the first inbound port or last outbound port in North America. The Boston port is rapidly becoming one of the fastest growing high-end cruise ship markets in the country.

The major U.S. ports are governed by Traffic Separation Schemes established by the U.S. Coast Guard and the U.S. Department of Transportation according to 33 CFR Chapter 1 Part 167. These channels, with specific latitude/longitude coordinates, direct incoming and outgoing traffic into different lanes for safe negotiation into U.S. ports. These schemes also provide Precautionary Areas where the direction of traffic is recommended. In Canada, the Canadian Traffic Separation Scheme was altered in 2003 to accommodate right whale critical habitat. Traffic was shifted east to avoid areas of right whale high density in the Bay of Fundy. In July 2007, the east-west leg of the Boston Traffic Separation Scheme was shifted approximately 12 degrees north to redirect shipping traffic through the Stellwagen Bank National Marine Sanctuary from an area of high whale density to an area of significantly lower whale density.

3.18.3 Eastern Gulf of Mexico

Major commercial shipping ports in the northeast GOMEX include Mobile, Alabama, and Tampa, Florida (Figure 3-8). Based on year 2,000 gross-tonnage data, these ports are respectively the thirteenth and seventeenth largest in the United States (USACE, 2004b). Lesser ports in the region include Charlotte, Panama City, Pensacola, and Port Manatee, all in Florida. A large amount of vessel traffic entering and leaving these ports crosses the Gulf to other U.S. and foreign ports.

A major shipping route traverses the eastern GOMEX, extending from the Port of New Orleans and passing to the south of the Florida Keys. The ports of New Orleans, Louisiana, and Houston, Texas, are two of the busiest shipping ports in the United States. Seven of the 10 largest ports in the United States, based on gross tonnage for the year 2000, are situated on the GOMEX (USACE, 2004b).

This page is intentionally blank.

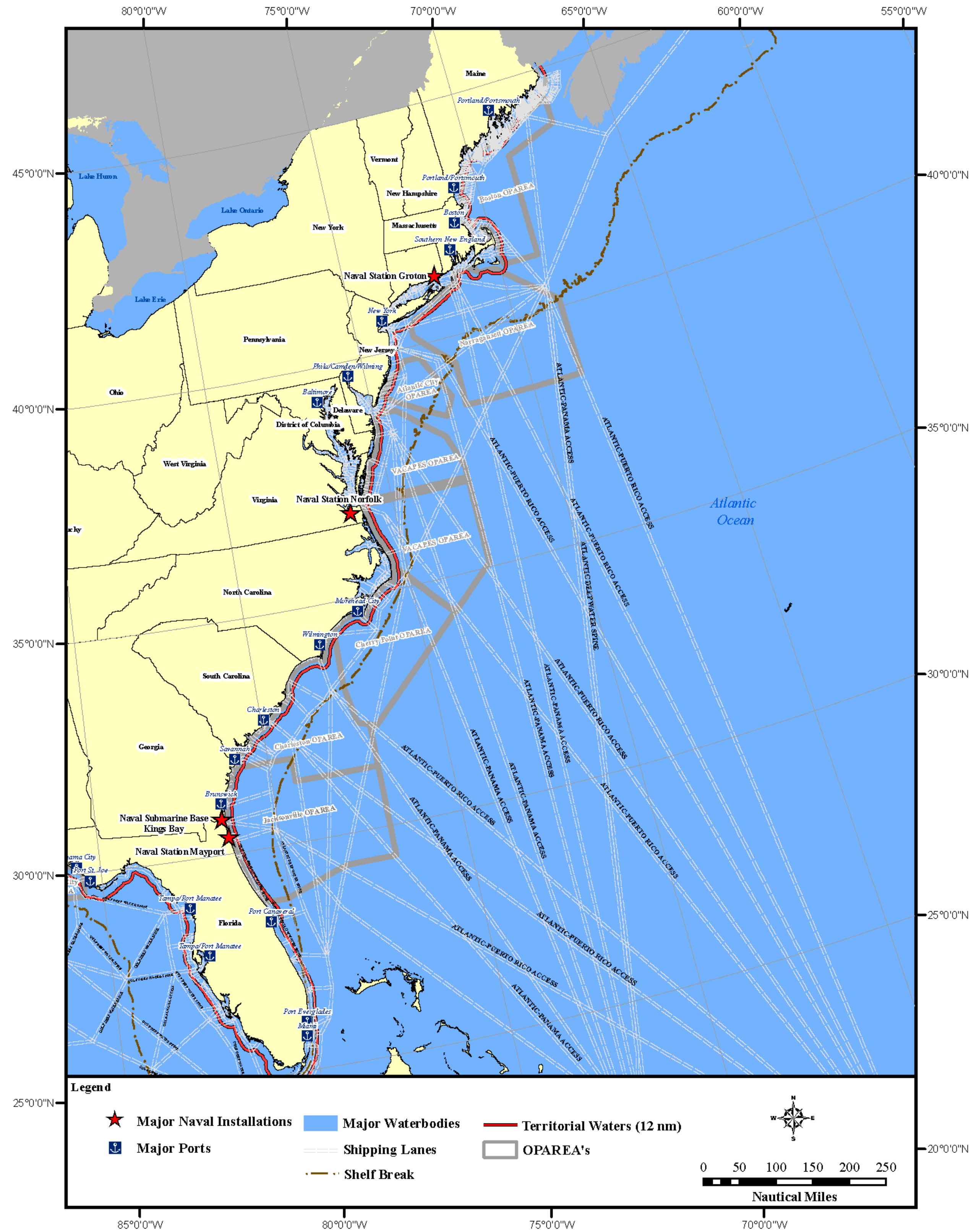


Figure 3-7. Atlantic Shipping Routes

This page is intentionally blank.

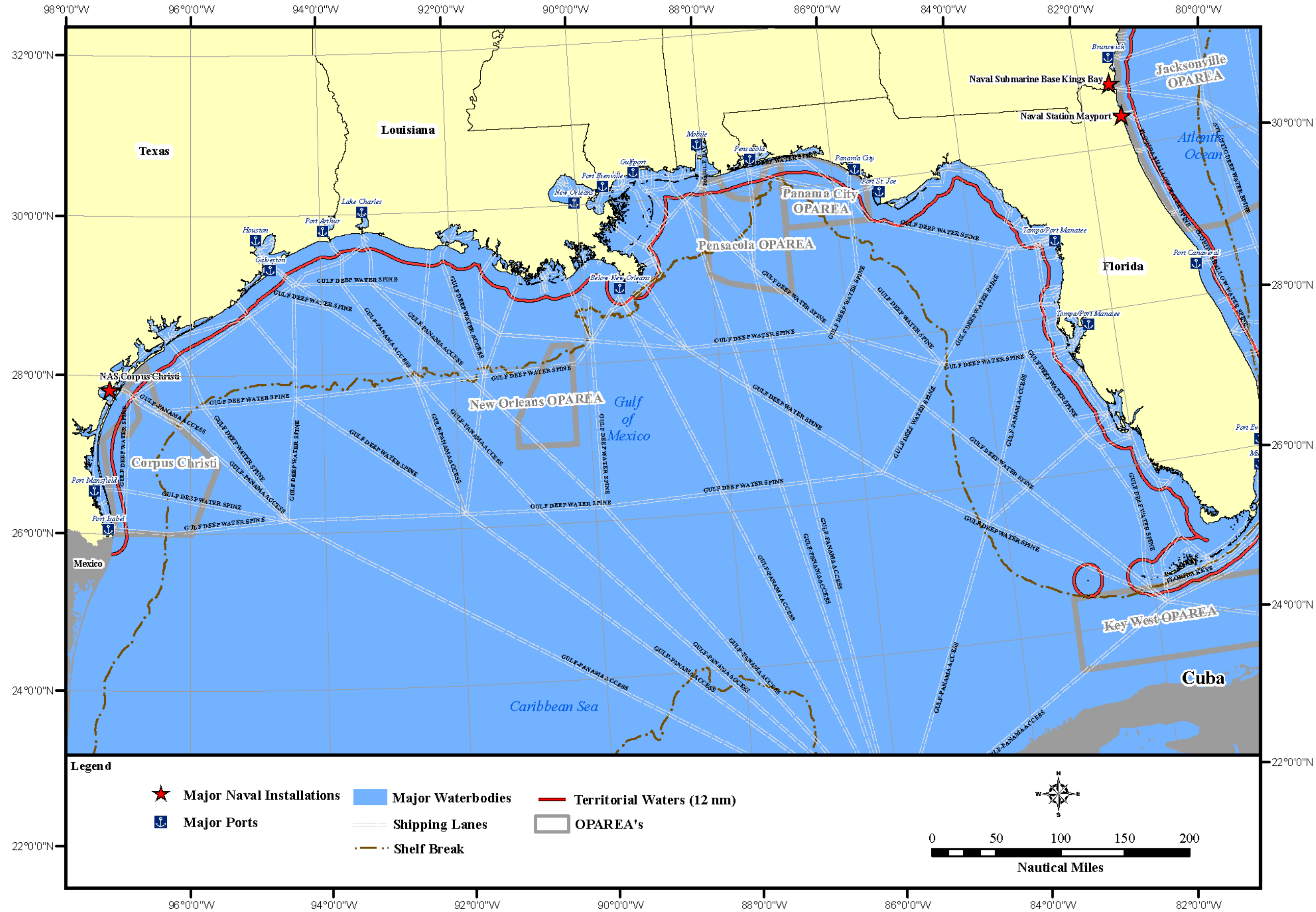


Figure 3-8. GOMEX Shipping Routes

This page is intentionally blank.

3.18.4 Western Gulf of Mexico

As the largest maritime state, Texas receives major economic benefits from its ports. There are 14 deepwater ports along the Gulf Coast with access to both the Pacific and Atlantic Oceans and served by the Gulf Intracoastal Waterway system (Figure 3-8). Houston is the busiest port in Texas, followed by Beaumont, Corpus Christi, and Texas City. Houston is ranked among the top three ports of the United States The Port of Houston is also second to the Port of South Louisiana, which is the largest volume shipping port in the Western Hemisphere and fourth largest in the world (USACE, 2004a). Houston ranked first in the nation in total foreign tonnage handled, second in total tonnage in the United States, and tenth busiest in the world (Port of Houston Authority, 2006). In 2005, approximately 200 million tons of cargo moved through the port (Port of Houston Authority, 2006). Petroleum and petroleum products compose a large portion of shipments destined for other parts of the country. Two major railroads and 150 trucking lines connect the port to various parts of the United States, Canada, and Mexico.

3.19 SCUBA DIVING

Typical considerations for scuba divers relevant to all portions of the Study Area are dive depth limitations. Specifically, the Professional Association of Diving Instructors (PADI) suggests that certified openwater divers limit their dives to 18 m (60 ft). More experienced divers are generally limited to 30 m (100 ft); in general, no recreational diver should exceed 40 m (130 ft) (PADI, 2006).

3.19.1 Atlantic Ocean, Offshore of the Southeastern United States

Scuba diving and snorkeling are popular year-round recreational activities in the southeastern United States. In the winter, the warmer waters of the southeast make for a more pleasant diving experience than colder, more northerly waters (e.g., those off the coasts of Virginia and Maryland). Most recreational scuba diving occurs at points of interest (such as shipwrecks, reefs, and marine sanctuaries) usually close to shore.

Five artificial reefs are located in the ocean off the Virginia coast and support offshore sport fishing and recreational diving. Three of these offshore artificial reefs—Blackfish Bank, Parramore Reef, and Wachapreague Reef—are located north of the mouth of Chesapeake Bay. Although recreational fishing and other recreational boats range throughout the Virginia and Maryland coastal waters, most recreational diving occurs within a few miles of shore.

Scuba diving and snorkeling are popular recreational activities along the entire coastline. The CHPT OPAREA and North Carolina, with its warm Gulf Stream waters and preponderance of shipwrecks, provides ideal diving locations. Although diving occurs year-round, it varies in intensity with season (i.e., there are more diver trips in summer than in winter). There are 47 named diving spots; all are located within 40 km (22 NM) of shore.

3.19.2 Atlantic Ocean, Offshore of the Northeastern United States

Recreational diving in New England is focused mainly on wreck diving. Hundreds of ship wrecks are in the northeastern OPAREAs Study Area, many of which are accessible by divers. Another focus of scuba divers is on artificial reefs not formed by wrecks. These are composed of sunken tanks, tires, and other expended materials. Of the many sites frequented by recreational divers in the area, very few are natural. Unlike dive sites in the Caribbean Sea that are associated with coral reefs, dive sites in this area are typically associated with artificial habitats (i.e., human-made submerged structures that are colonized by or attract organisms). These structures range widely in size and type and are composed of a wide variety of materials.

Recreational divers can access dive sites by boat or by entering the water directly from the beach. For the recreational diver, there are many opportunities in the Study Area for dives of less than 39.6 m (130 ft). Many popular dive sites can be found right along the coast of Massachusetts and are accessible from the beach or by boat. New Jersey has many diving opportunities ranging from wreck dives to artificial reefs. Even in the colder waters of Maine and Nova Scotia, recreational diving is still a popular activity.

3.19.3 Eastern Gulf of Mexico

The area within and adjacent to the GOMEX contains many sites popular with scuba divers and snorkelers. Many of the favored dive sites are wrecks and artificial reefs. There are close to 300 named dive sites off Florida from the Florida Keys to Pensacola. The vast majority of these sites are located within 40 km (21.7 NM) of shore and can be explored year-round. Most of the many sites frequented by divers in the eastern GOMEX are artificial reefs. A modest number of these artificial reefs are shipwrecks; many of these are quite old, with little of the structure remaining.

3.19.4 Western Gulf of Mexico

Most recreational diving in GOMEX waters off Texas occurs at the Flower Garden Banks National Marine Sanctuary. The Flower Garden Banks was designated as an National Marine Sanctuary in 1992 as a result of the combined efforts of recreational divers and researchers and is one of 13 NMSs managed by NOAA (NOAA, 2006a).

There are three separate areas of the Flower Garden Banks National Marine Sanctuary: East Flower Garden, West Flower Garden, and Stetson Banks. The Flower Garden Banks are some of the most unique areas in the GOMEX because they contain the northernmost coral reefs in the United States. Together, the East and West Flower Garden Banks are composed of nearly 1.4 km^2 (0.4 NM^2) of coral reef. There have been at least 280 different species of fish documented within the sanctuary as well as loggerhead turtles and 20 species of sharks and rays (NOAA, 2006a). The variety of species living in this unique habitat allows the area to be used for a diverse number of activities including recreational diving and recreational and commercial fishing. Recreational divers are the most frequent and largest users of the sanctuary. The area is visited by nearly 3,000 divers a year, and this number is expected to increase as the area is consistently rated as a favorite spot for dives in North America (NOAA, 2006a).

The Flower Garden Banks is also a prime location for oil and gas production. An estimated 150 production platforms are located within 40.2 km (21.7 NM) of the sanctuary and serve as an artificial reef that provides a habitat for an array of different species and an attractive spot for recreational divers (NOAA, 2006a). Hiett and Milon (2002) estimated that the market value for diving at artificial reefs created by oil and gas structures in the GOMEX was $119 per person per day. Meanwhile, Ditton and Baker (1999) found the market value estimates for diving at various types of artificial reefs in Texas totaled $184.68 for residents and $193.80 for nonresidents (Pendleton, 2004). These estimates do not include nonmarket values. Based on two types of contingent valuation methods of estimates for diving, the nonmarket value of various types of artificial reefs in Texas ranges from $44.46 to $74.93 per person per day.

The preferred diving depth for most dive charters is 21.3 to 30.5 m (70 to 100 ft) (Pendleton, 2004). The Texas Parks and Wildlife Department reef sites off Galveston, Port Aransas, and Freeport are reported as the most popular destinations for boat captains. These areas are visited most frequently in the summer months (June through August) and visited less frequently in the spring (Pendleton, 2004).

3.20 MARINE MAMMAL WATCHING

Marine mammal watching, often referred to as whale watching, includes any cetacean species such as dolphins, whales, and porpoises. Tours are conducted by boat, aircraft, or from land. This type of marine tourism includes any of these activities, formal or informal, that possesses at least some commercial component whereby consumers view, swim with, or listen to any of these approximately 83 cetacean species (Hoyt, 2001). Hoyt (2001) has conducted the most recent, comprehensive survey of the whale-watching industry in the past decade. His findings show that whale watching is growing at a rapid pace worldwide. Between 1991 and 1998, an increase on average of 12.1 percent per year has been realized internationally, with a mean of 13.6 percent per year from 1994 to 1998. Compared to these worldwide figures, the whale-watching industry in the United States has only grown at a pace of about 7.8 percent from the period of 1994 to 1998. During the last year comprehensively surveyed, approximately 4.3 million people participated in the industry, contributing nearly $357 million dollars in sales to operators of whale-watching tours (Hoyt, 2001).

Of the whale watches operating in the AFAST EIS/OEIS Study Area, New England has the greatest number of businesses (36) and sales ($1.24 million). New England ranks fourth in whale watching by operator numbers and economics in the United States and follows the states of Alaska, California, and Hawaii. At the time of this comprehensive study (Hoyt, 2001), whale watching occurred in 22 communities in New England. The majority of operations occurred within Massachusetts where 17 operators were conducting whale watching out of popular ports such as Gloucester, Provincetown, Boston, Barnstable, and Plymouth. The 25-year focus of whale watching on the Stellwagen Bank area has contributed to its popularity and helped to establish the current NMS there. Table 3-14 provides an overview of the statistics by state in New England. The most commonly viewed whales in the New England portion of the AFAST Study Area includes humpback whales, fin whales, right whales, minke whales, sei whales, and Atlantic white-sided dolphins (Whale Center of New England [WCNE], 2007).

Table 3-14. Overview of Whale Watch Statistics by State in the New England Area

State	Number of Operators	Number of Boats	Sales (in millions)
Massachusetts	17	30 – 35	$24
New Hampshire	4	6 – 10	$1.9
Maine	14	18 – 24	$4.4
Rhode Island	1	1	$0.3

Source: Hoyt, 2001

Hoyt (2001) examined the rest of the eastern United States and GOMEX as a combined region. He found that the region ranked sixth out of seven areas in the United States behind the state of Washington. The study concluded that 25 operators bring in about $355,000 from boat-based and land-based whale watching. Concentrations of the industry are highest for the AFAST Study Area in Hilton Head Island, South Carolina; St. Petersburg, Florida; Panama City, Florida; and Jupiter, Florida. A number of single operators exist in cities extending along the entire west coast of Florida, all the way to Key West. Other noted areas for whale watching include Corpus Christi, Texas, and for educational and/or academic-related tours there are Pascagoula, Mississippi; Galveston, Texas; and Sarasota, Florida (Hoyt, 2001). Based on the distribution and abundance of the various marine mammal species and the location of these popular ports for whale watching, a number of these operators likely provide viewing opportunities primarily for the coastal and nearshore populations of dolphins, particularly Atlantic bottlenose dolphins.

3.21 CULTURAL RESOURCES AT SEA

The potential cultural resources within each of the OPAREAs include prehistoric and historic resources (shipwrecks) as well as man-made obstructions. Prehistoric resources, in depths of less than approximately 100 m (328 ft) remain and may be considered a cultural resource (or archaeological sites).

It is anticipated that these sites would be buried under sediments that have accumulated over the centuries (i.e., they would be buried well below the affected environment associated with sonar training). Thus, it is anticipated that there would be no archaeological sites in the affected environment. The following discussion of cultural resources at sea relates only to shipwrecks within the Study Area.

3.21.1 Atlantic Ocean, Offshore of the Southeastern United States

The southeastern Atlantic coast contains the VACAPES OPAREA, CHPT OPAREA, and the JAX/CHAS OPAREA.

This area lies off the Delmarva Peninsula and extends southward to Cape Hatteras, North Carolina. Numerous barrier islands run along shore of the current U.S. mainland. Assateague, Chincoteague, and Kitty Hawk are well-known for historic settlements. Trade ships ran along the barriers islands, and many were lost from either running aground or during large storms and hurricanes. The area offshore of Virginia was very active for early European exploration and settlement during the late 1500s and early 1600s, and commercial shipping was widespread during the seventeenth century (MMS, 2007g). Most known shipwrecks in the VACAPES

OPAREA are located near the coast, well landward of the shelf break. Approximately 159 shipwrecks are located in the VACAPES OPAREA.

NOAA's Automated Wreck and Obstruction Information System (AWOIS) was queried to determine the best representation of the potential for shipwrecks and obstructions within and adjacent to the VACAPES OPAREA (NOAA, 2007c).

CHPT OPAREA lies solely off the North Carolina coast. It is bounded by Cape Hatteras to the north, includes Pamlico Sound, and extends to Cape Lookout point. The area includes numerous barrier islands; thus, the propensity for a high distribution of shipwrecks is likely. The Outer Banks, as this string of islands are called, jut offshore of North Carolina in a manner that would have been unanticipated in early shipping times.

The first recorded shipwreck for this area took place in 1585 when one of John White's flagships, the *Tyger*, wrecked at Ocracoke Inlet. In the more than four centuries since then, historians estimate that over 1,000 ships have been lost along coastal North Carolina, earning the treacherous waters the nickname "The Graveyard of the Atlantic." The highest concentrations of shipwrecks are in the vicinity of Cape Hatteras, where the clash of cold northern currents and the northbound Gulf Stream forms the shallows of Diamond Shoals.

Many of the recent shipwrecks that have occurred in the area are marked on various navigational charts, and some are popular dive and fishing locations. Most of these known shipwrecks in the CHPT OPAREA are located near the coast, well landward of the shelf break. Approximately 104 known shipwrecks are located within the CHPT OPAREA. Notable shipwrecks include the Civil War era ironclad USS Monitor, and numerous World War II-era vessels belonging to both Allied and Axis forces. In fact, the area off the coast of Look Out Shoals was referred to at the time as "Torpedo Junction" because during the beginning of World War II German submarines (U-Boats) sank many U.S. and Allied vessels.

The USS Monitor lies in approximately 72 m (236 ft) of water and in 1975 was designated as the first U.S. Marine Sanctuary. Currently, the sanctuary is administered by NOAA and lies 25.75 km (13.9 NM) just south of Cape Hatteras. NOAA's AWOIS was queried to determine the best representation of the potential for shipwrecks and obstructions within and adjacent to the CHPT OPAREA (NOAA, 2007c).

The JAX/CHASN OPAREA extends from just south of Charleston, South Carolina, to Cape Canaveral, Florida, and encompasses the entire Georgia Bight. The Georgia Bight contains numerous barrier islands called the "Sea Islands" and runs the length of the coast from Charleston to Cumberland Island, Georgia, lessening as this stretch reaches Cape Canaveral. The Georgia Bight differs from the above-mentioned OPAREAs in that it has the highest tides of the southeastern United States. These tides are semi-diurnal, with an average fluctuation of 2.4 to 3.4 m (7.9 ft to 11.2 ft). Since such large volumes of water are exchanged, preservation for shipwrecks in this area remains low. However, NOAA has established a marine sanctuary, located at the 20-m (65.6-ft) bathymetry line that does encompass one archaeological (and paleontology) site.

Most of the known shipwrecks in the JAX/CHASN OPAREA are located near the coast, well landward of the shelf break. Shipwrecks in the Atlantic, off the Georgia-Florida coast, were often the result of natural causes such as severe weather. Determining spatial patterns for shipwrecks in the Atlantic has not been a very productive task. Furthermore, these patterns tend to vary due to wind strength and direction and current shears. It is clear that most deep-water shipwrecks were due to hurricanes (Garrison et al., 1989). Literature indicates that less than 2 percent of pre-twentieth century ships and less than 10 percent of all ships reported lost in the Atlantic between 1500 and 1945 have known locations (Garrison et al., 1989). Ships have been lost since the beginning of Spanish exploration until the modern age of shipping and commerce.

There are several known shipwrecks from the Civil War (1860–1865). The *CSS Georgia* and the *USS Water Witch* are two such known ships that were used to guard harbor entrances and channels. The *CSS Georgia* was a Confederate ship that sat 4.8 km (2.6 NM) south of Savannah. This ship was used to guard the city by keeping Union forces at bay (USACE, 2006). The *USS Water Witch*, which was stationed in Ossabaw Sound, was captured by Confederate forces in 1864. Excavations occur periodically on these ships. Additionally, according to NOAA records, a number of shipwrecks lie in Cumberland Sound and the channel along Kings Bay Naval Submarine Base. Some of these wrecks have been investigated; however, at present, it is not know whether any of these qualify for eligibility listing on the National Register of Historic Places—it is only known that they do exist. These are the Caroline, Raptor, Twilight, and Sparta vessels.

NOAA's AWOIS was queried to determine the best representation of the potential for shipwrecks and obstructions within and adjacent to the JAX/CHASN OPAREA (NOAA, 2007c).

3.21.2 Atlantic Ocean, Offshore of the Northeastern United States

The northeastern Atlantic coast contains the Boston OPAREA, the Narragansett OPAREA, and the Atlantic City OPAREA.

The northern portion of the MAB, Georges Bank, and the Gulf of Maine contain numerous shipwrecks. Merchantman (freighters/tankers), ships-of-war, passenger ships, submarines, and fishing vessels have been sunk, lost, or run aground. Natural activities and features have played important roles in creating submerged cultural resources; those include powerful currents, such as the Labrador Current; winds (including cold fronts); rough seas (gales, hurricanes, blizzards); coastal topography (e.g., Cape Cod and Vineyard Sound); and shallow water and sandbars (Isles of Shoals, Nantucket Shoals). Not to be omitted are wars and battles that have resulted in more than 10,000 documented shipwrecks that occurred in the Boston OPAREA, the Narragansett OPAREA, and the Atlantic City OPAREA from 1500 to 1999. The Revolutionary War and the War of 1812 contributed to numerous ship losses. Specifically, World Wars I and II used submarine warfare, which resulted in numerous cargo ships being destroyed. The approximate numbers of shipwrecks found in state waters are astronomical: Maine (1,400); Massachusetts (5,300); Rhode Island (1,200); New York (1,550); and New Jersey (2,100).

The undulating coastline and large number of coastal islands associated with Maine and Massachusetts have been a factor in the loss of many vessels. For example, 74 shipwrecks documented from 1717 to 1914 were sunk along the eastern shore of Cape Cod, from Nantucket Sound to the mouth of Cape Cod Bay. The majority of the shipwrecks off Rhode Island, New York, and New Jersey can be attributed to the heavy coastal ship traffic and the associated higher frequency of wrecks attributed to onboard fires, collisions, nautical equipment breakdowns, or being torpedoed by German submarines. Some of the well-known wrecks in the vicinity of the Study Area include the *USS Squalus* off Portsmouth, New Hampshire; the *Portland*, which sank during the "Portland Gale" in the fall of 1898 in what is now Stellwagen Bank National Marine Sanctuary; and the Italian luxury liner *Andrea Doria* (1956) and tanker *Argo Merchant* (1976), both of which sank off Nantucket Island, Massachusetts.

NOAA's AWOIS was queried to determine the best representation of the potential for shipwrecks and obstructions within and adjacent to the northeastern OPAREAs (NOAA, 2007c).

3.21.3 Eastern Gulf of Mexico

The Eastern GOMEX OPAREA contains the Key West, Panama City, and Pensacola, Florida OPAREAs. A study was performed by Coastal Environments, Inc. (1977) that mapped the locations of known shipwrecks. A literature search of both shipwrecks and reported ship losses was combined with factors that are known to affect ship loss (reefs, straits, approaches to seaports, and storms). The results were used to determine areas that may have a high probability for shipwrecks. Although this study focused on the GOMEX, it is now well-known that shipwrecks tend to be clustered around navigational hazards and port entrances. During the 1960s, the U.S. National Park Service, or NPS began to investigate shipwrecks and document their conditions and locations.

Although most historic archaeological resources in the GOMEX are shipwrecks, other types of historic sites (such as the Ship Shoal Lighthouse) exist. A literature search for reported ship losses and known shipwrecks was conducted as part of an archaeological resources baseline study for the northern GOMEX. This study indicated that less than 2 percent of pre-twentieth century ships reported lost in the Gulf, and less than 10 percent of all ships reported lost between 1500 and 1945, have known locations (110 out of 1,589). Thus, little is known about the locations of historic shipwrecks in the GOMEX (MMS, 2007g).

In 1989 Texas A&M University completed a study for MMS and identified over 4,000 potential shipwreck locations within the GOMEX. MMS completed another study in 2003 and identified over 2,100 potential shipwreck locations in federal waters (shipwreck sites known to lie in state waters were not included in this database) (MMS, 2007g). The location coordinates are known for only 191 of the 1,202 shipwrecks off the coast of Florida, with the majority having occurred in the last two centuries. Known shipwrecks are often marked on various navigational charts, and some are popular dive and fishing locations.

Within the Florida Keys NMS, a trail of historic shipwrecks is scattered along the treacherous coral reefs and buried in the sandy shallows a few miles off the Florida Keys. There are many reasons these ships lie broken on the bottom including an inability to accurately determine position, inaccurate charts, lack of navigational aids (lighthouses and buoys), unpredictable currents, lack of wind, storms, and human error. The nine sites on the Shipwreck Trail represent three broad periods of the Keys maritime history: European Colonial, American, and Modern. These nine shipwreck sites are the City of Washington, the Benwood, the Duane, the Eagle, the San Pedro, the Adelaide Baker, the Thunderbolt, the North America, and the Amesbury (NOAA, 2007f).

NOAA's AWOIS was queried to determine the best representation of the potential for shipwrecks and obstructions in the eastern GOMEX (NOAA, 2007c).

3.21.4 Western Gulf of Mexico

The western GOMEX contains the Corpus Christi, Texas OPAREA. As stated previously, the locations of all shipwrecks in the GOMEX are not known. However, a study was completed to determine the factors involved in the preservation of shipwrecks in the GOMEX. It was determined that, due to differences in sedimentation rates across the north-central Gulf, it is expected that preservation potential in the eastern part of this area (off Mississippi and Alabama) will be higher than the preservation potential in the western part (off Louisiana) (MMS, 2007g). However, this does not include the Texas coast, where well-known shipwrecks have been discovered and excavated within recent years.

The *Belle* is one of the most important shipwrecks ever discovered in North America. The excavation, conducted in a cofferdam in Matagorda Bay, lies just to the north of Corpus Christi, Texas. The excavation lasted almost a year and produced an amazing array of finds, including the hull of the ship, three bronze cannons, thousands of glass beads, bronze hawk bells, pottery, and even the skeleton of a crew member. The 1 million artifacts represent a kit for building a seventeenth-century European colony in the New World (Texas Historic Commission [THC], 2007). The *Belle* was one of La Salle's ships used for exploration and colonization of the region.

NOAA's AWOIS was queried to determine the best representation of the potential for shipwrecks and obstructions within the western GOMEX (NOAA, 2007c).

4. ENVIRONMENTAL CONSEQUENCES

4.1 INTRODUCTION

This chapter discusses the potential environmental effects associated with the use of active sonar technology and the improved extended echo ranging (IEER) system during Atlantic Fleet active sonar training (AFAST) activities and research, development, test, and evaluation (RDT&E) and active sonar maintenance activities. As stated previously, the Navy is developing the Advanced Extended Echo Ranging (AEER) system as a replacement to the IEER system. Potential environmental effects associated with the AEER system are expected to be similar to those for the IEER system. Therefore, refer to the potential effects associated with the IEER system for the potential effects associated with the AEER system For the purposes of this document, training and RDT&E activities involving active sonar and the IEER system are collectively referred to as "active sonar activities."

Environmental and socioeconomic resources identified and described in Chapter 3 are presented and analyzed in this chapter using the same order. As stated in Section 3.3, the oceanographic features in the AFAST Study Area (i.e., water currents, water characteristics, and bathymetry) would not be affected by the Proposed Action. As such, these features are not analyzed in this chapter.

This chapter delineates between United States (U.S.) territorial waters (shoreline to 22 kilometers [km], or 12 nautical miles [NM]) and non-territorial waters (seaward of 22 km [12 NM]) for the purposes of applying the appropriate regulation (i.e., National Environmental Policy Act of 1969 [NEPA] or Executive Order [EO] 12114) followed to analyze the potential environmental effects. Specifically, text related to *territorial waters* is printed in italic type.

Proposed mitigation measures have been developed to reduce potential environmental effects; Chapter 5 details these measures. In addition, Chapter 6 provides an assessment of the cumulative impacts discussed here in Chapter 4.

4.2 SCIENTIFIC AND ANALYTICAL BASIS FOR DETERMINING SIGNIFICANCE

In determining the potential environmental consequences, an approach was established to differentiate between significant and nonsignificant effects. This approach involved using either documented regulatory criteria or the best scientific information available at the time of analysis. Further, the extent of significance was evaluated using the context (e.g., short- versus long-term; territorial versus non-territorial) of the Proposed Action and the intensity (severity) of the potential effect. The introductory paragraph of each subsection explains the methodology used in the respective analysis.

4.3 MARINE HABITAT

This section will analyze the potential effects to sediment quality, water quality, and marine debris with regards to expended components listed in Table 4-1.

4.3.1 Contaminated Sediment

This section analyzes the potential effects to sediment quality as a result of unrecovered sonobuoys, torpedo components, ADCs, and EMATTs. Scuttled sonobuoy seawater batteries on the ocean floor are expected to have negligible adverse effects to the sediments, because electrodes are largely exhausted during operations and residual constituent dissolution will occur more slowly than the releases from activated seawater batteries. In addition, corrosion and colonization of encrusting marine organisms on the sonobuoy housing would reduce leaching rates. Therefore, this section focuses on sonobuoy, ADC, and EMATT batteries, as well as Otto Fuel II (OF II) combustion byproducts. This section will not analyze XBTs since they do not have batteries and, therefore, do not have the potential to affect sediments. Other unrecovered components associated with sonobuoys, torpedoes, ADCs, and EMATTs are not analyzed since they do not contain chemicals or metals that could potentially affect sediments.

Since the bottom types within territorial and non-territorial waters along the East Coast and Gulf of Mexico are similar, potential effects were considered to be the same for all OPAREAs without regard to territorial or non-territorial waters.

4.3.1.1 Sonobuoys

AFAST active sonar activities and RDT&E activities involving scuttled sonobuoys will occur within and adjacent to all OPAREAs in the AFAST Study Area. Residual metals associated with scuttled sonobuoys on the ocean floor represent a potential source of contamination to sediments. Sediments act as a reservoir for metals that are attracted to particulate organic carbon and, as such, may be available as a source of chronic stress to the benthic community.

A recent battery study involved a comprehensive survey of 775 aquatic Aid to Navigation (AtoN) sites in California. After finding only 37 stations with expended batteries, the U.S. Coast Guard selected eight locations to represent potentially impaired habitats. Ten site sediment samples and a minimum of four background sediment samples were generally collected at each AtoN location. The sediment samples were collected from a depth of 0 to 10 centimeters (cm) (0 to 4 inches [in]) and adjacent to or within 15 meters (m) (50 feet [ft]) of each battery location. Sediments were analyzed for all metal constituents in the subject batteries. Metals were either below National Oceanic and Atmospheric Administration (NOAA) screening levels or consistent with background levels for all but two sites. At one site, copper levels were elevated; at the other site, mercury and cadmium were elevated. A repeat survey at the high-mercury site failed to detect risk-bearing concentrations. Because the statistical analysis in the sampling strategy targeted the worst-case scenario, it was determined that, while batteries may have contributed risks at these two sites, no further investigation was required. This study did yield data where lead concentrations were between the NOAA effects range low (ERL) and effects range median (ERM), but all levels of lead were less than the levels from reference AtoN sites without battery power. Neither of the AtoN studies included evaluations of factors that mediate risks; hence, both present very conservative assessments. Factors that are generally understood to reduce risks associated with contaminated sediments include acid-volatile sulfide concentrations and organic carbon; both act to reduce the bioavailability of metals (EPA, 2001).

Table 4-1. Expended Materials

Device	Description	Expended Materials	Number Expended per Year
Sonobuoys	A sonobuoy is an expendable device used for the detection of underwater acoustical energy and for conducting vertical water column temperature measurements. There are three basic types of standard range sonobuoys: passive, active, and XBTs. Sonobuoys are launched from aircraft and ships and XBTs are launched from aircraft, ships, and submarines. Following deployment, sonobuoys descend to specified depths and transmit data measurements to a surface unit via an electrical suspension cable or radio frequency signal. A float containing a wire antenna is inflated and goes to the surface from the depth at which the buoy is deployed (27 or 122 m[90 or 400 ft]). Approximately one-sixth of the buoys used would be at a depth of 122 m (400 ft), and five-sixths would be at 27 m (90 ft). The signals can be relayed from this point and depths to a receiving station located on an aircraft or ship or at a land-based communications facility. Sonobuoys are cylindrical devices about 12.5 cm (4.9 in) in diameter and 91 cm (36 in) in length, weighing from 6 to 18 kg (14 to 39 lbs). At water impact, a seawater battery activates and deployment initiates. The parachute assembly (aircraft only) is jettisoned and sinks away from the unit, while a float containing an antenna is inflated. The subsurface assembly descends to a selected depth, and the sonobuoy case falls away and sea anchors deploy to stabilize the hydrophone (underwater microphone). The operating life of the seawater battery is eight hours, after which the sonobuoy scuttles itself and sinks to the ocean bottom.	• Parachute assembly (12-18 in diameter nylon chute) and nylon cord • Fabric floatation unit • Lead chloride, cuprous thiocyanate, or silver chloride batteries, Lithium batteries, or Lithium iron disulfide thermal batteries (XBT does not contain a battery) • Plastic casing • Metal clips • Nylon strap • Electrical wiring (90-400 ft of copper wiring, depending on type of sonobuoy) • Drogue (fabric and frame; on some sonobuoys) • Hydrophone/transducer assembly (configuration and amount of material varies depending on type of sonobuoy – sonobuoys may contain up to 38 lbs of material)	• Listening sonobuoys: 27,500 • Tonal sonobuoys: 5,853 • Explosive source sonobuoys: 872 • Receiver sonobuoys: 308
MK–46/54 Lightweight Torpedoes	MK-46 is a deep-diving, high-speed lightweight torpedo that is launched from helicopters, fixed-wing aircraft, and surface ships. It has an OTTO II fuel propulsion system and uses active acoustic homing. The MK-54 is launched similar to the MK-46. An exercise torpedo that actually "runs" is referred to as an "EXTORP." Only about 10% of the lightweight shots would be "runners." All MK-54 shots are "runners." The remaining shots are non-running "dummy" torpedo shapes called "REXTORPs." All torpedoes are recovered. A parachute assembly for aircraft-launched torpedoes is jettisoned and sinks.	• Protective nose cover • Suspension bands • Air stabilizer • Release wire • Propeller baffle • Steel-jacketed lead ballast weights • OTTO Fuel II • Parachute (4-9 ft^2.; only on air dropped torpedoes)	• 24 Torpedoes

Device	Description	Expended Materials	Number Expended per Year
MK-48 Torpedo	Heavy weight exercise torpedo about 580 cm (19 ft) in length and 53 cm (21 in) in diameter. All MK-48 torpedoes are recovered.	• Guidance wire (maximum of 0.1 cm [0.04 in] in diameter and composed of a very fine thin-gauge copper-cadmium core with a polyolefin coating); Up to 15 mi of wire is deployed during a run • Flex hose (250 ft long) • OTTO Fuel II	• 32 Torpedoes
ADC	Typically cylinder-shaped about 102 to 280 cm (40 to 110 in) in length, 8 to 15 cm (3 to 6 in) in diameter, and weighing between 3 and 57 kg (7 and 125 lbs).	• Lithium sulfur dioxide battery • Metal casing • Wires	• 225 ADCs
EMATT	Approximate shape of 12 by 91 cm (5 by 36 in) with a weight of 10 kg (21 lbs)	• Parachute assembly (12-18 in diameter nylon chute) and nylon cord • Lithium sulfur dioxide battery • Metal casing • Metal clips • Nylon strap • Electrical wiring	• 725 EMATTs

ADC = acoustic device countermeasures; EMATT = expendable mobile acoustic training target; XBT = expendable bathythermograph; cm = centimeters; ft = feet; in = inches; kg = kilograms; lbs = pounds; m = meter; mi = miles,;

An earlier battery study for mostly zinc-mercury batteries was conducted with similar findings. The U.S. Coast Guard conducted research to determine the environmental effects associated with discharged AtoN batteries that contained a 500-gram (g) (17.6-ounce [oz]) zinc electrode coated with approximately 20 g (0.7 oz) of elemental mercury (Borener and Maugham, 1998). Among other items, their research included conducting environmental assessments for prototypical AtoN disposal sites in the Chesapeake Bay, Tampa Bay, Tennessee River, Puget Sound, and Midway Island. The field studies at each location included analytical data for 10 samples per AtoN station, with each sample representing 126 square meters (m^2) (1356.3 square feet (ft^2) for all the prototype investigations except Midway Island. At Midway Island, analytical data from 27 samples per AtoN station were taken, with each sample representing 46 m^2 (495.1 ft^2). Bioaccumulation data were also obtained, generally from sessile (permanently attached) organisms on the batteries.

While the results of the prototype investigations varied by location, some common trends were noted. A full description of each study is available in individual reports for each prototype investigation. In general, the extremely low percentage of methylmercury, and thus low risk potential, was common at all of the characteristic aquatic environments examined. Very low mercury concentrations were detected in the aquatic organisms, even those attached to batteries. These findings indicate no significant risk to human health or the aquatic food chain. The limited spatial distribution of mercury within the sediment was another common pattern detected during the prototype program. In most cases, elevated sediment concentrations, if any, were confined to the immediate vicinity (less than 1 m [3 ft]) of batteries, and in all cases, if there were any slightly elevated concentrations detected beyond 1 m (3 ft), the condition was limited to 10 m (33 ft) or less from the AtoN. In almost all cases, even the highest mercury concentrations measured around AtoNs was within the range of background concentrations measured as part of the investigation or reported in the literature for the general prototype investigation area.

Borener and Maugham (1998) concluded that there was no correlation between the measurement of metals in sediments in Chesapeake Bay, Tennessee River, Puget Sound, and Midway Island and proximity to batteries. In Tampa Bay, there was a high density of discarded batteries and broken batteries. It was determined that when both of these conditions occur, the sediment levels approach and in some cases even exceed levels associated with adverse effects on sediment dwelling organisms. However, even in the areas of highest battery concentrations and greatest percentage of broken batteries, methylmercury concentrations and levels in aquatic organisms are well below those that pose a potential risk to humans or the aquatic food chain.

Additionally, in the Chesapeake Bay Field Study, sediment and biological sampling was conducted at five locations as part of the prototype investigation program. The results of these investigations revealed a pattern which indicates little, if any, detectable risk due to spent primary AtoN batteries. For example, the Pooles Island Light, examined as part of the Chesapeake Prototype investigation, exhibited a combination of characteristics that could result in environmental risk. The habitat around Pooles Island Light is abundant with fish, crabs, and other marine organisms that could accumulate mercury. Discarding batteries onto the rip rap (e.g. large rocks used to inhibit erosion) at the base of the light resulted in a large number of broken batteries, and the oyster bar substrate could prevent mixing of the mercury from the batteries into the sediment. The result could be relatively high concentrations of mercury at the sediment interface. However, investigations at the site revealed a pattern of association of mercury levels that correlated with the sediment type, not with the presence of batteries. The lack of any evidence of mercury risk due to batteries at this type of site supports the conclusion that batteries pose a very small risk to the aquatic environment in general (Borener and Maugham, 1998).

A U.S. Coast Guard document entitled "Aids to Navigation (AtoN) Battery Release Reporting Requirements" found that lead and other metals from batteries associated with AtoN sites represented levels that were less than reportable quantities under Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) 103(a) (U.S. Coast Guard, 1994). Since sonobuoy batteries are smaller and retain little metal after use, no reportable quantities should be present in sea floor deposits.

Furthermore, an update to the 1996 Environmental Assessment for the Canadian Forces Maritime Experimental and Test Ranges (CFMETR) near Nanoose, British Columbia, was completed in 2005 by Environmental Sciences Group, Royal Military College of Canada. This document analyzed chemical effects associated with expendable components from activities involving sonobuoys, torpedoes, EMATTs, and ADCs (ESG, 2005). Specifically, the analysis focused on lead, copper, lithium, and Otto fuel. The document stated that metal contaminants were most likely to concentrate in fine-grained particulate matter, especially when smaller than 63 μm. The findings of the EA demonstrated that CFMETR operations did not cause a measurable effect on sediment quality (ESG, 2005).

Given the mobility characteristics for the most soluble battery constituent, lead chloride, and the extensive studies conducted by the U.S. Coast Guard, there is low potential for substantial accumulation of contaminant in sediments. *Therefore, there will be no significant impact to sediments from sonobuoy batteries in territorial waters under the No Action Alternative, Alternative 1, Alternative 2, or Alternative 3.* In addition, there will be no significant harm to sediments from sonobuoy batteries in non-territorial waters under the No Action Alternative, Alternative 1, Alternative 2, or Alternative 3.

4.3.1.2 Torpedoes

Releases of Otto Fuel II combustion byproducts will be diluted and dispersed in the water column due to flowing ocean currents. The potential effects of these chemical releases will be similar to those described for water quality (refer to Section 4.3.3). Due to the rapid dilution of chemical releases, accumulation of chemicals in sediments is not likely. This is further substantiated by the results of the CFMETR EA, which determined that Otto fuel would not cause a measurable effect on sediment quality (ESG, 2005).

Upon completion of an MK-46 EXTORP run, two steel-jacketed lead ballast weights are released to lighten the torpedo, allowing it to rise to the surface for recovery. Each ballast weighs 16.8 kilograms (kg) (37 pounds [lbs]) and sinks rapidly to the bottom. In addition to the ballasted MK-46 EXTORPs, MK-46 REXTORPs launched from P-3s also must be ballasted for safety purposes. Ballast weights for these REXTORPs are similarly released to allow for missile recovery. Ballasting the MK-46 REXTORP for P-3 use requires six ballasts, totaling 82 kg (180 lbs) of lead. In areas of soft bottom, ballasts would be buried quickly in the sediments.

The EPA saltwater quality standard for lead is 8.1 µg/L continuous and 210 µg/L maximum (EPA, 2006). Lead is a minor constituent of seawater, with a background concentration of 0.02 to 0.4 µg/L (Kennish, 2001).

The metallic lead of the ballast weights is unlikely to mobilize into the sediment or water as lead ions for three reasons. First, the lead is jacketed with steel, which means that the surface of the lead would not be exposed directly to the actions of seawater. Second, even if the lead were exposed, the general bottom conditions of slightly basic and low oxygen content (i.e., a reducing environment) would prohibit the lead from ionizing. In addition, only a small percentage of lead is soluble in seawater. Finally, in soft-bottom areas, the lead weights would be buried due to the velocity of their impact with the bottom. Sediments are generally anoxic and thus no lead would be ionized (DON, 1996a). Studies at other ranges have shown the impact of lead ballasts to be minimal, as they are buried deep in sediments where they are not biologically available (Environmental Sciences Group, 2005). There would be no cumulative effects from the lead ballasts due to the low probability of mobilization.

Therefore, there will be no significant impact to sediments from Otto Fuel II combustion byproducts in territorial waters under the No Action Alternative, Alternative 1, Alternative 2, or Alternative 3. In addition, there will be no significant harm to sediments from OF II combustion byproducts in non-territorial waters under the No Action Alternative, Alternative 1, Alternative 2, or Alternative 3.

4.3.1.3 Acoustic Device Countermeasures

Lithium sulfur dioxide battery cells power ADCs. The chemical reactions of the lithium sulfur dioxide batteries will be highly localized and short-lived, and the ocean currents will greatly diffuse concentrations of the chemicals leached by the batteries. Due to the rapid dilution of chemical releases, accumulation of chemicals in sediments is not likely. This is further substantiated by the results of the CFMETR EA, which determined that lithium in batteries would not cause a measurable effect on sediment quality (ESG, 2005). *Therefore, there will be no significant impact to sediments from ADC batteries in territorial waters under the No Action Alternative, Alternative 1, Alternative 2, or Alternative 3.* In addition, there will be no significant harm to sediments from ADC batteries in non-territorial waters under the No Action Alternative, Alternative 1, Alternative 2, or Alternative 3.

4.3.1.4 Expendable Mobile Acoustic Training Target

Lithium sulfur dioxide battery cells also power EMATTs. The chemical reactions of the lithium sulfur dioxide batteries will be highly localized and short-lived, and the ocean currents will greatly diffuse concentrations of the chemicals leached by the batteries. Due to the rapid dilution of chemical releases, accumulation of chemicals in sediments is not likely. This is further substantiated by the results of the CFMETR EA, which determined that lithium in batteries would not cause a measurable effect on sediment quality (ESG, 2005). *Therefore, there will be no significant impact to sediments from EMATT batteries in territorial waters under the No Action Alternative, Alternative 1, Alternative 2, or Alternative 3.* In addition, there will be no significant harm to sediments from EMATT batteries in non-territorial waters under the No Action Alternative, Alternative 1, Alternative 2, or Alternative 3.

4.3.2 Marine Debris

There are several reasons why marine debris is left in the environment. Firstly, the ocean currents often carry expended materials away from the activity area; thus, identification and retrieval efforts are difficult, if not impossible, to conduct following an activity. Secondly, retrieval personnel are limited in the overall depth of their dives for safety reasons. For example, deep dives require the implementation of specialized equipment. The Professional Association of Diving Instructors (PADI) suggests that recreational divers should not exceed 40 m (130 ft) (PADI, 2006). Diving beyond these depths is considered technical diving, which typically requires one or more mandatory decompression stops during ascension (NOAA Ocean Explorer, 2008). The overall safety risks associated with technical dives and the equipment required to conduct these types of dives greatly restricts its implementation.

A retrieval effort could be conducted using an unmanned remotely operated vehicle (ROV), but this method is neither efficient nor practical. There are very few ROVs available to the Navy with the capability to complete this type of operation, especially in deep water (greater than 1,524 m [5,000 ft]). Due to the manpower and support required to operate an ROV and support vessel and retrieve objects from the ocean floor, this method would not be timely enough to accurately locate the debris, as the ocean currents would invariably scatter the debris.

Lastly, there is the possibility that retrieval operations would create additional disturbance (water turbidity, damage to the equipment during retrieval, etc.) to the environment. As such, this section will analyze whether expending active sonar activity components into the Study Area will adversely contribute to the marine habitat. Refer to Sections 4.4.12, 4.5.3, and 4.8.4 for an analysis of potential entanglement effects to marine mammals, sea turtles, and seabirds from expended materials.

Although the amount of marine debris expended could be more concentrated under Alternatives 1 and 2 as opposed to the amount under the No Action Alternative and Alternative 3, this analysis assumes that the active sonar activities would not occur in the exact locations during each individual event. As such, potential effects were considered to be the same for all OPAREAs without regard to alternative, or territorial or non-territorial waters.

4.3.2.1 Sonobuoys

A sonobuoy is approximately 13 cm (5 in) in diameter, 1 m (3 ft) long, and weighs between 6 and 18 kg (14 and 39 lb), depending on the type. In addition, aircraft-launched sonobuoys deploy a nylon parachute of varying sizes, ranging from 0.15 to 0.35 m^2 (1.6 to 3.8 ft^2). The shroud lines range from 0.30 to 0.53 m (12 to 21 in) in length and are made of either cotton polyester with a 13.6-kg (30-lb) breaking strength or nylon with a 45.4-kg (100-lb) breaking strength. All parachutes are weighted with a 0.06-kg (2-ounce) steel material weight, which causes the parachute to sink from the surface within 15 minutes. At water impact, the parachute assembly, battery, and sonobuoy will sink to the ocean floor where they will be buried into its soft sediments or land on the hardbottom where they will eventually be colonized by marine organisms and degrade over time. These components are not expected to float at the water surface or remain suspended within the water column. Over time, the amount of materials will accumulate on the ocean floor. However, the active sonar activities using sonobuoys will not likely occur in the exact same location each time. Additionally, the materials will not likely settle in the same vicinity due to ocean currents.

Therefore, there will be no significant impact to marine habitat from scuttled sonobuoys or their expended components in territorial waters under the No Action Alternative, Alternative 1, Alternative 2, or Alternative 3. In addition, there will be no significant harm to marine habitat from scuttled sonobuoys or their expended components in non-territorial waters under the No Action Alternative, Alternative 1, Alternative 2, or Alternative 3.

4.3.2.2 Torpedoes

The MK-48 will be used during active sonar activities. These devices are approximately 580 cm (19 ft) long and 53 cm (21 in) in diameter). The guidance wire is a maximum of 0.11 cm (0.043 in) in diameter and composed of a very fine thin-gauge copper-cadmium core with a polyolefin coating. The tensile breaking strength of the wire is a maximum of 19 kg (42 lb) and can be broken by hand. Up to 28 km (15 miles [mi]) of wire is deployed during a run, which will sink to the sea floor at a rate of 0.5 km/hr (0.29 kn). The metallic flex hose protects the guidance wire and prevents it from forming loops as it leaves the tube.

An assortment of air launch accessories, all of which consist of non-hazardous materials, would be expended into the marine environment during air launching of MK-46 or MK-54 torpedoes, which are lightweight torpedoes. Depending on the type of launch craft used, MK-46 launch accessories may be comprised of a protective nose cover, suspension bands, air stabilizer, release wire, and propeller baffle (DON, 1996). MK-54 air launch accessories may be comprised of a nose cap, suspension bands, air stabilizer, sway brace pad, arming wire, and fahnstock clip (DON, 1996a).

Upon completion of an MK-46 EXTORP run, two steel-jacketed lead ballast weights are released to lighten the torpedo, allowing it to rise to the surface for recovery. Each ballast weighs 16.8 kg (37 lbs) and sinks rapidly to the bottom. In addition to the ballasted MK-46 EXTORPs, MK-46 REXTORPs launched from maritime patrol aircraft (MPA) must also be ballasted for safety purposes. Ballast weights for these REXTORPs are similarly released to allow for missile recovery. Ballasting the MK-46 REXTORP for MPA use requires six ballasts, totaling 82 kg (180 lbs) of lead.

The small amount of material will be spread over a relatively large area. This expended material will settle to the ocean bottom and will be covered by sediments over time. Due to the small size and low density of materials, these components are not expected to float at the water surface or remain suspended within the water column. Over time, the amount of materials will accumulate on the ocean floor. However, the TORPEX activities will not likely occur in the exact same location each time. Additionally, due to ocean current, the materials will not likely settle in the same vicinity. *Therefore, there will be no significant effect to marine habitat from expended torpedo components in territorial waters under the No Action Alternative, Alternative 1, Alternative 2, or Alternative 3.* In addition, there will be no significant harm to marine habitat from expended torpedo components in non-territorial waters under the No Action Alternative, Alternative 1, Alternative 2, or Alternative 3.

4.3.2.3 Acoustic Device Countermeasures

ADCs are approximately 102 to 280 cm (40 to 110 in) in length and 8 to 15 cm (3 to 6 in) in diameter, and they weigh between 3 and 57 kg (7 and 125 lb). ADCs are approximately the same size as sonobuoys. Once expended, ADCs and their associated batteries will sink to the ocean floor throughout the AFAST Study Area and will be covered with sediments over time. The small amount of expended material will be spread over a relatively large area. Due to the small size and low density of the materials, these components are not expected to float at the water surface or remain suspended within the water column. Over time, the amount of materials will accumulate on the ocean floor, but due to ocean currents, the materials will not likely settle in the same vicinity. *Therefore, there will be no significant impact to marine habitat from expended ADCs or their components in territorial waters under the No Action Alternative, Alternative 1, Alternative 2, or Alternative 3.* In addition, there will be no significant harm to marine habitat from expended ADCs or their components in non-territorial waters under the No Action Alternative, Alternative 1, Alternative 2, or Alternative 3.

4.3.2.4 Expendable Mobile Acoustic Training Target

EMATTs are approximately 12 by 91 cm (5 by 36 in) and weigh approximately 10 kg (21 lb). EMATTs are much smaller than sonobuoys and ADCs. EMATTs, their batteries, parachutes, and other components will scuttle and sink to the ocean floor throughout the AFAST Study Area and will be covered by sediments over time. In addition, the small amount of expended material will be spread over a relatively large area. Due to the small size and low density of the materials, these components are not expected to float at the water surface or remain suspended within the water column. Over time, the amount of materials will accumulate on the ocean floor, but due to ocean currents, the materials will not likely settle in the same vicinity. *Therefore, there will be no significant impact to marine habitat from expended EMATTs or their components in territorial waters under the No Action Alternative, Alternative 1, Alternative 2, or Alternative 3.* In addition, there will be no significant harm to marine habitat from expended EMATTs or their components in non-territorial waters under the No Action Alternative, Alternative 1, Alternative 2, or Alternative 3.

4.3.3 Water Quality

This section analyzes the potential effects to water quality from sonobuoy, ADC, and EMATT batteries; explosive source sonobuoys (AN/SSQ-110A), and Otto Fuel II combustion byproducts associated with torpedoes. This section does not analyze XBTs since they do not use batteries.

4.3.3.1 Sonobuoys

The analysis provided in this section focuses on potential effects to water quality as a result of expended sonobuoy components. The approach used to evaluate the potential effects associated with seawater batteries included comparing the expected concentrations of potentially toxic battery constituents with EPA water quality criteria that have been established for the protection of aquatic life (EPA, 2006) or the best available literature values that established conservative toxicity thresholds. In accordance with EPA guidance, the concentrations are expressed as dissolved metal, which is also consistent with the ionic form that would be released from active batteries. The EPA recommends application of the acute and chronic limits as 1-hour (hr) and 4-day means, respectively (Table 4-2). Either limit cannot be exceeded more than once every 3 years on the average.

Table 4-2. Threshold Values for Safe Exposure to Selected Metals

Metal	Acute Criteria (µg/L, 1-hr exposure)	Chronic (µg/L, 4-day mean exposure)
Lead	210	8.1
Silver	1.9	NA
Copper	4.8	3.1
Lithium[1]	6,000	NA

NA = no chronic value is available; µg/L = micrograms per liter; hr = hour
Note: EPA aquatic life criteria unless otherwise stated.
1. No EPA criteria available; values shown are based on literature (Kszos et al., 2003).

Sonobuoys consist of two main sections, a surface unit that contains the seawater battery and a metal subsurface unit. The seawater battery becomes energized following contact with the water and once submerged can hold approximately 164 milliliters (mL) of seawater. The batteries provide power to the sonobuoy electronics. Depending on the design of the sonobuoy, the seawater battery can have an operating life of up to 8 hours. Sonobuoy seawater battery electrodes are typically lead chloride, cuprous thiocyanide, or silver chloride. Lithium batteries are used to power subsurface units. Hydrogen gas is generated from the electrochemical reactions that occur within the battery compartment.

Of particular concern for water quality are the activated seawater batteries, as they release lead (Pb), silver (Ag), and copper (Cu) ions that are freely dissolved in the water column. Other constituents, including nickel-plated steel housing, lead solder, copper wire, and lead shot used for ballast, will theoretically pose lesser risks to the aquatic environment relative to the seawater batteries (Naval Facilities Engineering Command [NAVFAC], 1993). Most of these components are coated with plastic to reduce corrosion, providing an effective barrier to water exchange. On the housing, corrosion and colonization of encrusting marine organisms reduce leaching rates.

Scuttled sonobuoys on the ocean floor are expected to have negligible adverse effects on water quality, because electrodes are largely exhausted during operations and residual constituent dissolution will occur more slowly than the releases from activated seawater batteries. Therefore, this subsection describes the potential effects of batteries and residual explosive material on marine water quality in and surrounding the sonobuoy operation area. Because the types of sonobuoys and their corresponding battery components will likely vary over the course of the AFAST exercises, the present characterization evaluates the most likely chemical constituents (i.e., those associated with Directional Command-Activated Sonobuoy System (DICASS) 62D and 62E, and the explosive source sonobuoy [(AN/SSQ-110A)]) but should generally be applicable to other sonobuoys. A report prepared by Naval Facilities Engineering Command (NAVFAC) Southwest Division as part of the Quality Assurance Program for training in the use of sonobuoys in San Clemente, California (NAVFAC 1993), provides useful background for the assessment. Data presented in that report have been applied in evaluating chemical exposures associated with seawater battery functions.

Furthermore, an update to the 1996 Environmental Assessment for the Canadian Forces Maritime Experimental and Test Ranges (CFMETR) near Nanoose, British Columbia, was completed in 2005 by Environmental Sciences Group, Royal Military College of Canada. This document analyzed chemical effects associated with expendable components from activities involving sonobuoys, torpedoes, EMATTs, and ADCs (ESG, 2005). Specifically, the analysis focused on lead, copper, lithium, and Otto fuel. The document stated that metal contaminants were most likely to concentrate in fine-grained particulate matter, especially when smaller than 63 μm. The findings of the Environmental Assessment demonstrated that CFMETR operations did not cause a measurable effect on water quality (ESG, 2005).

In addition, water column effects on contaminant dispersal are dominated by physical mixing and diffusion properties and tend to be variable with both time and location. Few published studies have been performed on the water column in the area. As the volume of water in the AFAST Study Area is large, the contamination concentration would be very dilute and difficult to detect.

4.3.3.2 Sonobuoy Seawater Batteries

The approach used to evaluate effects associated with seawater batteries involved comparing the expected concentrations of potentially toxic battery constituents with EPA water quality criteria that have been established for the protection of aquatic life (EPA, 2006) or the best available literature values that established conservative toxicity thresholds (Table 4-3).

As stated previously, this assessment applies the findings from a study reported by NAVFAC (1993, Appendix D) in a sonobuoy training document developed for activities at San Clemente, California. The study involved a laboratory experiment where activated seawater batteries were held in a 64-liter (L) (17-gallon) seawater bath for 8 hours to provide an empirical estimate of expected leach rates for metals of concern. Water column concentrations of metals at the end of the exposure can be used to derive average leaching rates and can then be interpreted in the context of minimum current velocities to estimate maximum field exposures.

The exposure scenario applied in the NAVFAC report represents reasonable and conservative assumptions that have been retained for this analysis. It is assumed that only one seawater battery will occupy the test volume within its 8-hour operating life span. No vertical turbulence is applied, and the horizontal ocean current flow is set at 5 centimeters per second (cm/sec) (2 inches per second [in/sec]). For comparison, the weakest current reported in Section 3 for the North Atlantic is about 5 cm/sec(2 in/sec). Hence, the NAVFAC assumption represents a highly conservative dilution scenario relative to the selected location.

The sonobuoy battery experiment employed lead chloride batteries over an 8-hour period. The concentration of lead at the end of the exposure in the 64-L (17-gallon) bath was 0.2 milligrams per liter (mg/L) (NAVFAC, 1993 [Appendix D]). Hence, the total amount of lead leached from the battery was 0.2 milligrams (mg) × 64 L = 12.8 mg. As shown in the table below, the per-hour rate is then 1.6 milligrams per hour (mg/hr), and the milligrams-per-second rate is 0.000444 milligrams per second (mg/sec). Applying a highly conservative model wherein all of the lead released in a single second is contained within 1 mL, the concentration is 0.4 mg/L.

Considering each milliliter as a discrete parcel, a reasonable dilution model for a current velocity of 5 cm/sec (2 in/sec) assumes that the contaminated section is diluted by a factor of 2 per second. As such, the concentration released from the battery is diluted to 0.2 mg/L or 200 micrograms per liter (µg/L), in 2 seconds, which is less than the acute criteria of 210 µg/L, a criteria applied as a 1-hr mean (Table 4-2). Likewise, assuming the exponential factor of two dilutions, the concentration is less than the chronic limit (8.1 µg/L) in 7 seconds. Therefore, lead chloride batteries will not result in significant degradation to marine water quality. Refer to Table 4-3 for description and summary of the calculations performed to determine potential effects from scuttled lead chloride batteries.

Table 4-3. Calculations to Characterize Maximum Lead Exposure Concentrations

Description of Calculation	Operation	Result
Total amount of lead leached from the battery	0.2 mg/L × 64 L =	12.8 mg/8 hr
Per-hour rate	12.8 mg/8 hrs =	1.6 mg/hr
Per-second rate	1.6/hr/(60 min/hr × 60 sec/min) =	0.000444 mg/sec
Concentration into 1 mL	0.000444 mg/mL × 100) mL/L =	0.4 mg/L
2-second dilution	0.4/2 =	0.2 mg/L or 200 µg/L

hr = hours; µg/L = micrograms per liter; mg = milligram; mL = milliliter; L = liter

Lead chloride, with a dissociation constant (K_{sp}) of 1.0×10^{-4} is more soluble than other metals used in seawater batteries (e.g., silver chloride $K_{sp} = 1.56 \times 10^{-10}$ and copper thiocyanate $K_{sp} = 1.64 \times 10^{-11}$) (International Union of Pure and Applied Chemistry [IUPAC], 2006). The relatively large differences in the propensity of lead ions (Pb^{+2}) to solubilize relative to copper (Cu^{+2}) and silver (Ag^{+}) assures that potential effects from batteries employing silver chloride or copper thiocyanate are substantially lower than those for the lead chloride battery. While the copper thiocyanate battery also has the potential to release cyanide, a material often toxic to the marine environment, thiocyanate is tightly bound and can form a salt or bind to bottom sediments. Therefore, the risk associated with thiocyanate is very low.

As such, there will be no significant impact to water quality from seawater batteries associated with scuttled sonobuoys in territorial waters with the No Action Alternative, Alternative 1, Alternative 2, or Alternative 3. In addition, there will be no significant harm to water quality from seawater batteries associated with scuttled sonobuoys in non-territorial waters under the No Action Alternative, Alternative 1, Alternative 2, or Alternative 3.

4.3.3.2.1 Lithium Batteries

Lithium batteries are used in DICASS sonobuoys but not in the explosive source sonobuoy (AN/SSQ-110A). These batteries are contained within a metal casing housing sulfur dioxide, lithium metal, carbon, acetonitrile, and lithium bromide. During battery operation, the lithium reacts with the sulfur dioxide to form lithium dithionite. As with the seawater batteries, the reaction proceeds almost to completion once the cell is activated and only a small amount of reactants remain when the battery life terminates. In addition, the outside metal case can become encrusted from seawater processes, thus slowing the rate of further corrosion. Furthermore, a study conducted by Kszos et al. (2003) demonstrated that sodium ions mitigate the toxicity of lithium to sensitive aquatic species. Fathead minnows (*Pimephales promelas*) and the water flea (*Ceriodaphnia dubia*) were unaffected by lithium concentrations as high as 6 mg/L in the presence of tolerated concentrations of sodium. Hence, it is expected that in the marine environment where sodium concentrations are at least an order of magnitude higher than tolerance limits for the tested freshwater species, lithium would be essentially nontoxic. Because of these factors, it has been determined that lithium batteries do not result in significant degradation to marine water quality.

Therefore, there will be no significant impact to water quality from lithium batteries associated with scuttled sonobuoys in territorial waters under the No Action Alternative, Alternative 1, Alternative 2, or Alternative 3. In addition, there will be no significant harm to water quality from lithium batteries associated with scuttled sonobuoys in non-territorial waters under the No Action Alternative, Alternative 1, Alternative 2, or Alternative 3.

4.3.3.2.2 Thermal Batteries

The AN/SSQ-62D and E DICASS have been improved with the replacement of the standard lithium battery with a lithium iron disulfide thermal battery. An important component of the thermal battery is a hermetically sealed casing. The casing is Series 300 welded stainless steel .7- to 2.54-mm (0.03- to 0.1-in) thickness and is resistant to the battery electrolytes.

The electrochemical system in the thermal battery includes an iron disulfide cathode and a lithium alloy anode. In addition, the electrolyte mixture includes chloride, bromide, and iodide salts of lithium and potassium. This mixture is inert and nonconductive until the battery is activated. Upon activation, the mixture becomes molten and highly conductive, allowing the cathode to interact efficiently with the anode. The thermal source is a mixture of iron powder and potassium perchlorate. Ignition of the thermal source supplies the energy to melt the electrolyte, initiating conductivity. The active life of thermal batteries (approximately 1 hour) is less than that afforded by other sonobuoy batteries, but product development to extend its capacity to longer operation is ongoing.

Material safety data sheets were developed by the current supplier of thermal batteries to the Navy (Eagle-Picher Industries, Inc., Joplin, Missouri). While Eagle-Picher Industries, Inc. thermal batteries are technically exempt from the Hazard Communication Standard (29 Code of Federal Regulations [CFR] 1910.1200), or the "Right-to-Know Rule," because they do not "… release, or otherwise result in exposure to, a hazardous chemical under normal conditions of use" (Clarke, 1993), the company provides product information to ensure informed use (Eagle-Picher Industries, Inc., 2008). These sources state that during normal operation of a thermal battery, the greatest risk is from heat dissipated to the outer case (sufficient to cause severe burns under nonaquatic conditions). Also, thermal batteries should be treated as any other "live" source of electric power, in that they can cause electric shock. Due to the heat transmitted by thermal batteries, thermal shock or death would be expected for aquatic life exposed within close proximity of the battery unit unless it was contained within the sonobuoy housing. The thermal battery is located inside the transducer vessel of the sonobuoy and, hence, high temperature exposures should be minimized. In the case of extreme degradation of the battery housing on the sea floor, risks from thermal batteries would be similar to those from lithium batteries (i.e., negligible) but less because the iron alloy is less soluble.

Therefore, there will be no significant impact to water quality from thermal batteries associated with scuttled sonobuoys in territorial waters under the No Action Alternative, Alternative 1, Alternative 2, or Alternative 3. In addition, there will be no significant harm to water quality from thermal batteries associated with scuttled sonobuoys in non-territorial waters under the No Action Alternative, Alternative 1, Alternative 2, or Alternative 3.

4.3.3.3 Effects of Explosive Source Sonobuoys (AN/SSQ-110A)

Under water, the explosive reaction is relatively complete due to the higher-pressure conditions relative to air explosions. The concerns for the assessment discussed in this section are potential effects on water quality associated from the explosion byproducts. The acoustic effects associated with impulsive sound are addressed later in this chapter.

The explosive source sonobuoy (AN/SSQ-110A) is composed of two sections, an active (explosive) section and a passive section. The upper section is called the "control buoy" and is similar to the upper electronics package of the DICASS (AN/SSQ-62) sonobuoy. The lower section consists of two signal underwater sound (SUS) explosive payloads of Class A explosive weighing 1.9 kg (4.2 lb) each. The arming and firing mechanism is hydrostatically armed and detonated. Once in the water, the SUS charges explode, creating a loud acoustic signal. The explosive package consists largely of cyclotetramethylenetetranitramine (HLX) (90 percent research department explosive [RDX]) and small amounts (less than 0.3 g) of plastic-bonded molding powder (plastic bonded explosive [PBXN] PBXN 5 and hexanitrostilbene [HNS–IV], a detonator component).

The explosion creates an air bubble. Many of these gaseous byproducts travel within this bubble to the water surface and escape into the atmosphere. A small amount of the gas, however, dissolves into the water column. The product with greatest potential to result in toxicity is hydrogen fluoride compounds. These compounds are a reaction product associated with the booster charge that incorporates a Viton® fluoropolymer binder formulation to stabilize the highly explosive nitramines in HLX. The hydrogen fluoride is either produced directly in the explosion or from hydrolysis of another product. Explosive products were estimated using the Cheetah 4 computational program, and principal products are summarized in Table 4-4.

Table 4-4. Cheetah 4 Calculations of Detonation Product Weights

Explosive Products	C-J state (g/charge)	Ambient (g/charge)
Hydrogen fluoride compounds (HxFx)	24.6 (1.23%)	12.5 (0.63%)
Nitrogen (N_2)	634	675
Carbon dioxide (CO_2)	669	565
Water (H_2O)	211	332
Ammonia (H_3N)	61	13.4
Formic acid (CH_2O_2)	156	1.7
Ethylene (C_2H_6)	84.6	2.1

C-J state = initial detonation state; g = grams of detonation product
Note: Assumed a 2-kg [4.4-lb] explosive charge with a 3.7 to 0.5 ratio of HLX to booster

The United States has not produced any formal evaluation of risk to aquatic life from hydrogen fluorides; however, the European Union Committee for evaluation and control of the risks of existing substances has recommended risk-based benchmarks (Committee on Toxicity, Ecotoxicity and the Environment [CSTEE], 2000). Based on laboratory studies with freshwater species, they provide a probable no effect concentration (PNEC) of 0.9 and 0.4 mg/L for hard and soft water, respectively. These values are apparently close to background levels measured in many natural water bodies. Characterization of natural exposure levels and effects in saltwater are needed to provide further basis for the assessment of risks in marine systems. Only a small percentage (0.63 percent) of the available hydrogen fluoride explosive product is expected to become solubilized prior to reaching the surface and the rapid dilution that would occur upon mixture with ambient water. As such, it is unlikely that the explosive reactions associated with sonobuoys scuttling will contribute contaminant risks to the aquatic community.

Therefore, there will be no significant impact to water quality from explosion residuals associated with the explosive source sonobuoy (AN/SSQ-110A) in territorial waters under the No Action Alternative, Alternative 1, Alternative 2, or Alternative 3. In addition, there will be no significant harm to water quality from explosive residuals associated with the explosive source sonobuoy (AN/SSQ-110A) batteries in non-territorial waters under the No Action Alternative, Alternative 1, Alternative 2, or Alternative 3.

4.3.3.4 Torpedoes

Water quality effects that may result from the use of torpedoes can be grouped by their origin; that is, effects attributable to propulsion systems, to other chemical releases, or to expended accessories. For the purpose of the analysis of water quality effects associated with exercise torpedoes, the following discussion focuses on the origin of water quality effects so that exercise torpedoes with common propulsion systems are discussed as a group, as are exercise torpedoes with non-propulsion system chemical releases and expended accessories in common.

4.3.3.4.1 Otto Fuel II

During exercises involving the firing of torpedoes, Otto Fuel II combustion byproducts could be released into the marine environment. Otto Fuel II is used to power torpedoes. The fuel is combusted in the torpedo engine and the combustion byproducts are exhausted into the torpedo wake, which is extremely turbulent and causes rapid mixing and diffusion. These combustion byproducts include carbon dioxide, carbon monoxide, water, hydrogen gas, nitrogen gas, ammonia, hydrogen cyanide, and nitrogen oxides (Qadir et al., 1994). All of the byproducts, with the exception of hydrogen cyanide, are below the EPA water quality criteria.

Hydrogen cyanide does not normally occur in seawater and, if in high enough concentration, could pose a potential risk to both humans and marine biota. The EPA national recommendation for cyanide in marine waters is 1 μg/L, or approximately 1 part per billion [ppb], for both acute and chronic criteria (USEPA, 2006). The concentration of hydrogen cyanide exceeds the 1-hour recommended value; however, hydrogen cyanide is highly soluble in seawater and dilutes below the EPA criterion within 6.3 m (20.7 ft) of the torpedo.

Mk-46 and Mk-54 torpedoes are expected to discharge hydrogen cyanide concentrations of 280 ppb, and Mk-48 torpedoes are expected to discharge hydrogen cyanide concentrations ranging from 140 to 150 ppb (Ballentine, 1995; Qadir et al., 1994). These initial concentrations are well above the USEPA recommendations for cyanide. However, because it has extremely high solubility in seawater, hydrogen cyanide would diffuse to levels below 1 μg/L within 5.4 m (17.7 ft) of the center of the torpedo's path, and thus should pose no threat to marine organisms. Since simultaneous launches with multiple torpedoes launches are unlikely to be conducted in the same area within the AFAST Study Area, HCN will therefore not be additive and no significant environmental effects are expected.

In addition, the other exhaust products are not of concern because:

- Most Otto Fuel II combustion products, specifically carbon dioxide, water, nitrogen, methane, and ammonia, are naturally occurring in seawater.
- Several of the combustion products are bioactive. Nitrogen is converted into nitrogen compounds through fixation by certain blue-green algae, providing nitrogen sources and essential micronutrients for marine phytoplankton. Carbon dioxide and methane are integral parts of the carbon cycle in the oceans and are taken up by many marine organisms.
- Carbon monoxide and hydrogen have low solubility in seawater and excess gases will bubble to the surface.
- Although trace amounts of nitrogen oxides may be present, they are usually below detectable limits. In low concentrations, nitrogen oxides are not harmful to marine organisms and are a micronutrient source of nitrogen for aquatic plant life.

Therefore, there will be no significant impact to water quality from Otto Fuel II combustion byproducts in territorial waters under the No Action Alternative, Alternative 1, Alternative 2, or Alternative 3. In addition, there will be no significant harm to water quality from Otto Fuel II combustion byproducts in non-territorial waters under the No Action Alternative, Alternative 1, Alternative 2, or Alternative 3.

4.3.3.4.2 Sodium Fluorescein Dye

The exercise head section of the MK-46 and MK-54 torpedo is fitted with a dye container, which is filled with an estimated 109 g (3.7 oz) of sodium fluorescein dye (DON, 1996a). At the end of the torpedo exercise, the dye discharges into the seawater to enhance the visibility and facilitate the recovery of the torpedo. Sodium fluorescein dye is easily visible in very dilute solutions. The dye is commonly used to trace the flow of water and poses no harm to water quality or aquatic life at the concentrations that will occur during exercise torpedo operations. *Therefore, there will be no significant effect to water quality from torpedo sodium fluorescein dye in territorial waters under the No Action Alternative, Alternative 1, Alternative 2, or Alternative 3.* In addition, there will be no significant harm to water quality from torpedo sodium fluorescein dye in non-territorial waters under the No Action Alternative, Alternative 1, Alternative 2, or Alternative 3.

4.3.3.4.3 Components and Materials

MK-46, MK-54, and MK-48 torpedoes contain potentially hazardous or harmful (non-propulsion-related) components and materials. Only very small quantities of these materials, however, are contained in each torpedo. During normal exercise operations, the torpedo is sealed and is recovered at the end of a run; therefore, none of the potentially hazardous or harmful materials would be released to the marine environment. Potentially hazardous or harmful materials could be released on impact with a target or the sea floor. However, since the guidance system of the torpedo is programmed for target and bottom avoidance, the chance of an accidental release is remote. Further, since the amounts of potentially hazardous and harmful materials contained in each torpedo are very small, upon accidental release the materials would rapidly diffuse in the water column. *Therefore, there will be no significant impact to water quality from torpedo components and materials in territorial waters under the No Action Alternative, Alternative 1, Alternative 2, or Alternative 3.* In addition, there will be no significant harm to water quality from torpedo components and materials in non-territorial waters under the No Action Alternative, Alternative 1, Alternative 2, or Alternative 3.

4.3.3.5 Acoustic Device Countermeasures

The lithium in the lithium sulfur dioxide batteries reacts with the sulfur dioxide to form soluble hydrogen gas and lithium dithionite. The hydrogen gas eventually enters the atmosphere and the lithium hydroxide dissociates, forming lithium ions and hydroxide ions. The hydroxide is neutralized by the hydronium formed from hydrolysis of the acidic sulfur dioxide, ultimately forming water. Sulfur dioxide, a gas that is highly soluble in water, is the major reactive component in the battery. The sulfur dioxide ionizes in the water, forming bisulfite (HSO_3) that is easily oxidized to sulfate in the slightly alkaline environment of the ocean. Sulfur is present as sulfate in large quantities (i.e., 885 mg/L) in the ocean. *Therefore, there will be no significant impact to water quality from ADC batteries in territorial waters under the No Action Alternative, Alternative 1, Alternative 2, or Alternative 3.* In addition, there will be no significant harm to water quality from ADC batteries in non-territorial waters under the No Action Alternative, Alternative 1, Alternative 2, or Alternative 3.

4.3.3.6 Expendable Mobile Acoustic Training Target

As with ADCs, EMATTs also use lithium sulfur dioxide batteries; as such, the analysis and conclusion discussed previously applies. *Therefore, there will be no significant impact to water quality from EMATT batteries in territorial waters under the No Action Alternative, Alternative 1, Alternative 2, or Alternative 3.* In addition, there will be no significant harm to water quality from EMATT batteries in non-territorial waters under the No Action Alternative, Alternative 1, Alternative 2, or Alternative 3.

4.4 MARINE MAMMALS

Forty-three marine mammal species, including whales, dolphins, seals, and manatees, have possible or confirmed occurrence along the East Coast or in the Gulf of Mexico. Marine mammals with possible occurrences along the U.S. Atlantic coasts and within the Gulf of Mexico are provided in Section 3.6.

This section evaluates potential direct and indirect effects to marine mammals as a result of exposure to in-water sound. Specifically, a quantitative analysis was used to determine the potential effects to marine mammals associated with the use of active sonar, in addition to the explosive source sonobuoy (AN/SSQ-110A).

4.4.1 Acoustic Systems Analyzed

Table 4-5 presents all of the acoustic systems used during Atlantic Fleet active sonar activities. As stated previously, systems that are typically operated at frequencies greater than 200 kilohertz (kHz) were not analyzed. Note that some systems were found to have similar acoustic output parameters (i.e., frequency, power, deflection angles). For these systems, the system with the larger acoustic footprint was modeled which is representative of all similar systems.

Table 4-5. Acoustic Systems Analyzed

System	Frequency	Source Level (re 1µPa)	Associated Platform	System Description
AN/SQS-53	3.5 kHz	235 dB	DDG and CG hull-mounted sonar	ASW search, detection, and localization; utilized 70% in search mode and 30% track mode
AN/AQS-13	10.0 kHz	215 dB	Helicopter dipping sonar	ASW sonar lowered from hovering helicopter (approximately 10 pings/dip, 30 seconds between pings)
AN/AQS-22	4.1 kHz	217 dB	Helicopter dipping sonar	ASW sonar lowered from hovering helicopter (approximately 10 pings/dip, 30 seconds between pings)
Explosive source sonobuoy (AN/SSQ-110A)	Impulsive broadband	Classified	MPA deployed	ASW system consists of explosive acoustic source buoy (contains two 4.1 lb charges) and expendable passive receiver sonobuoy
AN/SSQ-125	MF	Classified	MPA deployed	ASW system consists of active sonobuoy and expendable passive receiver sonobuoy
AN/SQQ-32	HF	Classified	MCM over the side system	Detect, classify, and localize bottom and moored mines
AN/BQS-15	HF	Classified	Submarine navigational sonar	Only used when entering and leaving port

Table 4-5. Acoustic Systems Analyzed Cont'd

System	Frequency	Source Level (re 1μPa)	Associated Platform	System Description
AN/SQS-56	7.5 kHz	225 dB	FFG hull-mounted sonar	ASW search, detection, localization; utilized 70% in search mode and 30% track mode
MK-48 Torpedo	HF	Classified	Submarine fired exercise torpedo	Recoverable and non-explosive exercise torpedo; sonar is active approximately 15 min per torpedo run
MK-46/MK-54 Torpedo	HF	Classified	Surface ship and aircraft fired exercise torpedo	Recoverable and non-explosive exercise torpedo; sonar is active approximately 15 min per torpedo run
AN/SLQ-25 (NIXIE)	MF	Classified	DDG, CG, and FFG towed array	Towed countermeasure to avert localization and torpedo attacks (approximately 20 mins per use)
AN/SQS-53 and AN/SQS-56 (Kingfisher)	MF	Classified	DDG, CG, and FFG hull-mounted sonar (object detection)	Only used when entering and leaving port
AN/BQQ-10 and AN/BQQ-5	MF	Classified	Submarine hull-mounted sonar	ASW search and attack (approximately 1 ping every 2 hours when in use)
Tonal sonobuoy (DICASS) (AN/SSQ-62)	8 kHz	201 dB	Helicopter and MPA deployed	Remotely commanded expendable sonar-equipped buoy (approximately 12 pings, 30 secs between pings)
ADC MK-1, MK-2, MK-3 and MK-4	MF	Classified	Submarine deployed countermeasure	Expendable acoustic countermeasure (approximately 20 mins per use)
Submarine deployed countermeasure (NAE)	MF	Classified	Submarine deployed countermeasure	Expendable acoustic countermeasure (approximately 20 mins per use)

ADC – Acoustic Device Countermeasure; CG – Guided Missile Cruiser; DDG – Guided Missile Destroyer; DICASS – Directional Command-Activated Sonobuoy System; FFG – Fast Frigate; HF – High-Frequency; MF – Mid-Frequency; MPA – Maritime Patrol Aircraft EMATT – Expendable Mobile Acoustic Training Target

4.4.2 Assessing Marine Mammal Response to Sonar

Estimating potential acoustic effects on cetaceans entails answering the following questions:

- **What action will occur?** This requires identification of all acoustic sources that would be used in the exercises and the specific outputs of those sources. This information is provided in Section 4.4.1.
- **Where and when will the action occur?** The place, season, and time of the action are important to: Determine which marine mammal species are likely to be present. Species occurrence and density data (Chapter 3) are used to determine the subset of marine mammals for consideration and to estimate the distribution of those species.

  - Predict the underwater acoustic environment that would be encountered. The acoustic environment here refers to environmental factors that influence the propagation of underwater sound. Acoustic parameters influenced by the place, season, and time are described in Appendix H.

- **What are the predicted sound exposures for the species present?** This requires appropriate sound propagation models to predict the anticipated sound levels as a function of source location, animal location and depth, and season and time of the action. The sound propagation models and predicted acoustic exposures are described in detail in Appendix H.
- **What are the potential effects of sound on the species present?** This requires an analysis of the manner in which sound interacts with the physiology of marine mammals and the potential responses of those animals to sound. Section 4.4.3 presents the conceptual framework used in this EIS/OEIS to evaluate the potential effects of sound on marine mammal physiology and behavior. When possible, specific criteria and numeric values are derived to relate acoustic exposure to the likelihood of a particular effect.
- **How many marine mammals are predicted to be harmed or harassed?** This requires potential effects to be evaluated within the context of the existing regulations. Section 4.4.4 reviews the regulatory framework and premises upon which the effects analyses in this EIS/OEIS are based. Numeric criteria for MMPA harassment are presented in Section 4.4.5. Section 4.4.10 discusses the anticipated acoustic effects to ESA-listed and non-listed marine mammals.

4.4.3 Conceptual Biological Framework

The regulatory language of the MMPA and ESA requires that all anticipated responses to sound resulting from Navy exercises in AFAST active sonar activities be considered relative to their potential impact on animal growth, survivability and reproduction. Although a variety of effects may result from an acoustic exposure, not all effects will impact survivability or reproduction (e.g., short-term changes in respiration rate would have no effect on survivability or reproduction). Whether an effect significantly affects a marine mammal must be determined from the best available science regarding marine mammal responses to sound.

A conceptual framework (Figure 4-1) has been constructed to assist in ordering and evaluating the potential responses of marine mammals to sound. Although the framework is described in the context of effects of sonar on marine mammals, the same approach could be used for fish, sea turtles, sea birds, etc., that are exposed to other sound sources (e.g., impulsive sounds from explosions); the framework need only be consulted for potential pathways leading to possible effects.

4.4.3.1 Organization

The framework is a "block diagram" or "flow chart", organized from left to right, and grossly compartmentalized according to the phenomena that occur within each. These include the physics of sound propagation (physics component), the potential physiological responses associated with sound exposure (physiology component), the behavioral processes that might be affected (behavior component), and the life functions that may be immediately affected by changes in behavior at the time of exposure (life function – proximate). These are extended to longer term life functions (life function – ultimate) and into population and species effects.

Throughout the flow chart, dotted and solid lines are used to connect related events. Solid lines are those items which "**will**" happen, and dotted lines are those which "**might**" happen, but which must be considered (including those hypothesized to occur but for which there is no direct evidence). Blue dotted lines indicate instances of "feedback," where the information flows back to a previous block. Some boxes are colored according to how they relate to the definitions of harassment in the MMPA, with red indicating Level A harassment (injury) and yellow indicating Level B harassment (behavioral disturbance).

The following sections describe the flowthrough of the framework, starting with the production of a sound, and flowing through marine mammal exposures, responses to the exposures, and the possible consequences of the exposure. Along with the description of each block, an overview of the state of knowledge is described with regard to marine mammal responses to sound and the consequences of those exposures. Application of the conceptual framework to impact analyses and regulations defined by the MMPA and ESA are discussed in subsequent sections.

4.4.3.2 Physics Block

Sounds emitted from a source propagate through the environment to create a spatially variable sound field. To determine if an animal is "exposed" to the sound, the received sound level at the animal's location is compared to the background ambient noise. An animal is considered exposed if the predicted received sound level at the animal's location, is above the ambient level of background noise. If the animal is determined to be exposed, two possible scenarios must be considered with respect to the animal's physiology, responses of the auditory system and responses of non-auditory system tissues. These are not independent pathways and both must be considered since the same sound could affect both auditory and non-auditory tissues.

4.4.3.3 Physiology Block

4.4.3.3.1 Auditory System Response

The primary physiological effects of sound are on the auditory system (Ward, 1997). The mammalian auditory system consists of the outer ear, middle ear, inner ear, and central nervous system. Sound waves are transmitted through the outer and middle ears to fluids within the inner ear. The inner ear contains delicate electromechanical hair cells that convert the fluid motions into neural impulses that are sent to the brain. The hair cells within the inner ear are the most vulnerable to overstimulation by noise exposure (Yost, 1994).

Potential auditory system effects are assessed by considering the characteristics of the received sound (e.g., amplitude, frequency, duration) and the sensitivity/susceptibility of the exposed animals. Some of these assessments can be numerically based, while others will be necessarily qualitative, due to lack of information, or will need to be extrapolated from other species for

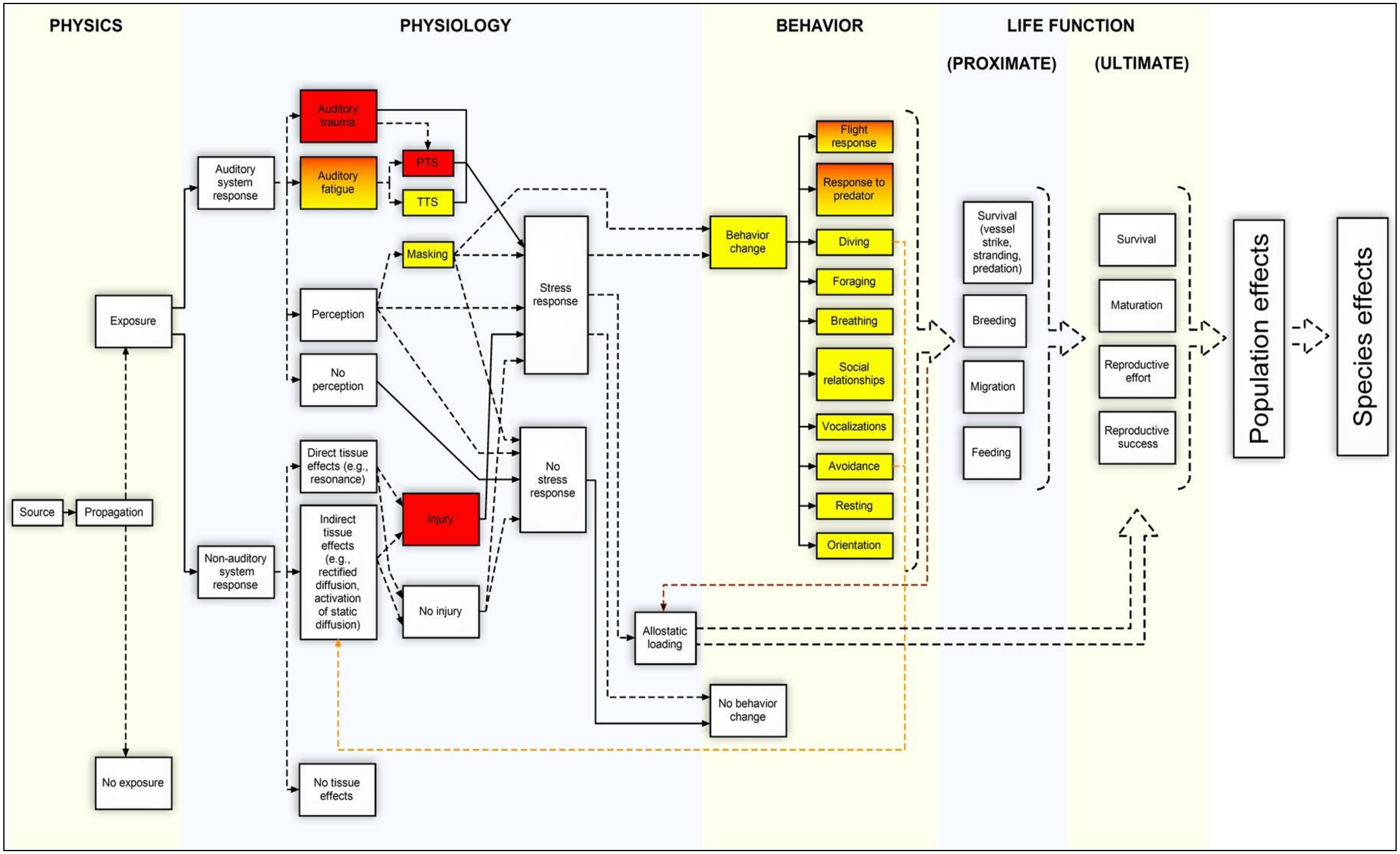


Figure 4-1. Conceptual biological framework used to order and evaluate the potential responses of marine mammals to sound.

This page is intentionally blank.

which information exists. Potential physiological responses to a sound exposure are discussed here in order of increasing severity, progressing from perception of sound to auditory trauma.

No Perception

The received level is not of sufficient amplitude, frequency, and duration to be perceptible to the animal (i.e., the sound is not audible). By extension, this cannot result in a stress response or a change in behavior.

Perception

Sounds with sufficient amplitude and duration to be detected within the background ambient noise are assumed to be perceived (i.e., sensed) by an animal. This category includes sounds from the threshold of audibility through the normal dynamic range of hearing. To determine whether an animal perceives the sound, the received level, frequency, and duration of the sound are compared to what is known of the species' hearing sensitivity. Within this conceptual framework, a sound capable of auditory masking, auditory fatigue, or trauma is assumed to be perceived by the animal.

Information on hearing sensitivity exists for approximately 25 of the nearly 130 species of marine mammals. Within the cetaceans, these studies have focused primarily on odontocete species (e.g., Szymanski et al., 1999; Kastelein et al., 2002; Nachtigall et al., 2005; Yuen et al., 2005; Houser and Finneran, 2006). Because of size and availability, direct measurements of mysticete whale hearing are nearly non-existent (Ridgway and Carder, 2001). Measurements of hearing sensitivity have been conducted on species representing all of the families within the pinniped families (Phocidae, Otariidae, Odobenidae) (Schusterman et al., 1972; Moore and Schusterman, 1987; Terhune, 1988; Thomas et al., 1990a; Turnbull and Terhune, 1990; Kastelein et al., 2002, 2005; Wolski et al., 2003;). Hearing sensitivity measured in these studies can be compared to the amplitude, duration and frequency of a received sound, as well as the ambient environmental noise, to predict whether or not an exposed marine mammal will perceive a sound to which it is exposed.

The features of a perceived sound (e.g., amplitude, frequency, duration, and temporal pattern) are also used to judge whether the sound exposure is capable of producing a stress response. Factors to consider in this decision include the probability of the animal being naïve or experienced with the sound (i.e., what are the known/unknown consequences to the animal from the exposure). Although preliminary because of the small numbers of samples collected, different types of sounds (impulsive vs. continuous broadband vs. continuous tonal) have been shown to produce variable stress responses in marine mammals. Belugas demonstrated no catecholamine (hormones released in situations of stress) response to the playback of oil drilling sounds (Thomas et al., 1990) but showed an increase in catecholamines following exposure to impulsive sounds produced from a seismic water gun (Romano et al., 2004). A dolphin exposed to the same seismic water gun signals did not demonstrate a catecholamine response, but did demonstrate an elevation in aldosterone, a hormone that has been suggested as being a significant indicator of stress in odontocetes (St. Aubin and Geraci, 1989; St. Aubin et al., 2001). Increases in heart rate were observed in dolphins to which conspecific calls were played, although no increase in heart rate was observed when tank noise was played back (Miksis et al., 2001). Collectively, these results suggest a variable response that depends on the characteristics of the received signal and prior experience with the received signal.

Audible natural and artificial sounds can potentially result in auditory masking, a condition that occurs when a sound interferes with an animal's ability to hear other sounds. Masking occurs when the perception of a sound is interfered with by a second sound and the probability of masking increases as the two sounds increase in similarity. It is important to distinguish auditory fatigue, which persists after the sound exposure, from masking, which occurs during the sound exposure. Critical ratios have been determined for pinnipeds (Southall et al., 2000; Southall et al., 2003) and detections of signals under varying masking conditions have been determined for active echolocation and passive listening tasks in odontocetes (Johnson, 1971; Au and Pawloski, 1989; Erbe, 2000). These studies provide baseline information from which the probability of masking can be estimated. The potential impact to a marine mammal depends on the type of signal that is being masked, important cues from conspecifics, signals produced by predators, or interference with echolocation are likely to have a greater impact on a marine mammal when they are masked than will a sound of little biological consequence.

Unlike auditory fatigue, which always results in a localized stress response because the sensory tissues are being stimulated beyond their normal physiological range, masking may or may not result in a stress response since it depends on the degree and duration of the masking effect and the signal that is being masked. Masking may also result in a unique circumstance where an animal's ability to detect other sounds is compromised without the animal's knowledge. This could conceivably result in sensory impairment and subsequent behavior change; in this case, the change in behavior is the *lack of a response* that would normally be made if sensory impairment did not occur. For this reason, masking also may lead directly to behavior change without first causing a stress response.

The most intense underwater sounds in the AFAST Study Area are those produced by sonars and other acoustic sources that are in the mid-frequency or higher range. The sonar signals are likely within the audible range of most cetaceans, but are very limited in the temporal, frequency, and spatial domains. In particular, the pulse lengths are short, the duty cycle low, the events are geographically and temporally dispersed, event durations are limited, and the tactical sonars transmit within a narrow band of frequencies (typically less than one-third octave). Finally, high levels of sound are confined to a volume around the source and are constrained by attenuation at mid- and high-frequencies, as well as by limited beam widths and pulse lengths. For these reasons, the likelihood of sonar operations causing masking effects is considered negligible in this EIS/OEIS.

Auditory Fatigue

The most familiar effect of exposure to high intensity sound is hearing loss, meaning an increase in the hearing threshold. This phenomenon is called a noise-induced threshold shift (NITS), or simply a threshold shift (TS) (Miller, 1974). A TS may be either permanent, in which case it is called a permanent threshold shift (PTS), or temporary, in which case it is called a temporary threshold shift (TTS). The distinction between PTS and TTS is based on whether there is a complete recovery of a TS following a sound exposure. If the TS eventually returns to zero (the threshold returns to the preexposure value), the TS is a TTS. If the TS does not return to zero but leaves some finite amount of TS, then that remaining TS is a PTS. Figure 4-2 (Two Hypothetical Threshold Shifts) shows one hypothetical TS that completely recovers, a TTS, and one that does not completely recover, leaving some PTS.

Although both auditory trauma and fatigue may result in hearing loss, the mechanisms responsible for auditory fatigue differ from auditory trauma and would primarily consist of metabolic fatigue and exhaustion of the hair cells and cochlear tissues. Note that the term "auditory fatigue" is often used to mean "TTS"; however, in this EIS/OEIS we use a more general meaning to differentiate fatigue mechanisms (e.g., metabolic exhaustion and distortion of tissues) from trauma mechanisms (e.g., physical destruction of cochlear tissues occurring at the time of exposure). Auditory fatigue may result in PTS or TTS but is always assumed to result in a stress response. The actual amount of threshold shift depends on the amplitude, duration, frequency, and temporal pattern of the sound exposure.

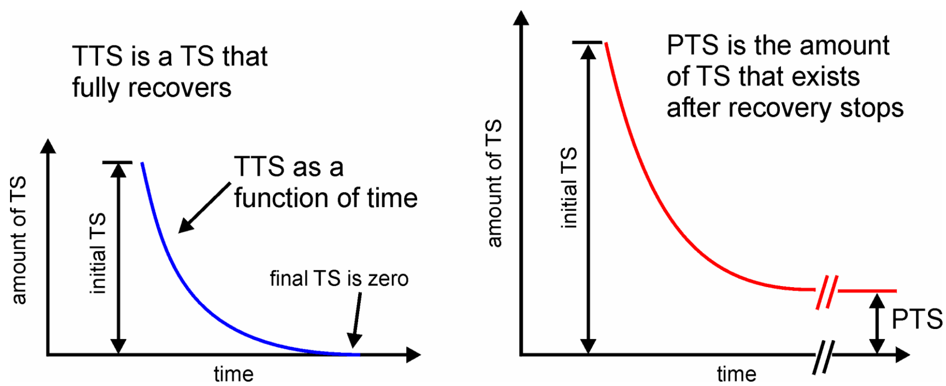


Figure 4-2. Two Hypothetical Threshold Shifts

There are no PTS data for cetaceans; however, a number of investigators have measured TTS in cetaceans (Schlundt et al., 2000, 2006; Finneran et al., 2000, 2002, 2005, 2007; Nachtigall et al., 2003, 2004). In these studies hearing thresholds were measured in trained dolphins and belugas before and after exposure to intense sounds. Some of the more important data obtained from these studies are onset-TTS levels – exposure levels sufficient to cause a just-measurable amount of TTS, often defined as 6 dB of TTS (for example, Schlundt et al., 2000). The existing cetacean TTS data show the following for the species studied in this EIS/OEIS and non-impulsive, mid-frequency sounds of interest:

- **The growth and recovery of TTS are analogous to those in land mammals.** This means that, as in land mammals, cetacean TSs depend on the amplitude, duration, frequency content, and temporal pattern of the sound exposure. Threshold shifts will generally increase with the amplitude and duration of sound exposure. For continuous sounds, exposures of equal energy will lead to approximately equal effects (Ward, 1997). For intermittent sounds, less TS will occur than from a continuous exposure with the same energy (some recovery will occur during the quiet period between exposures) (Kryter et al., 1965; Ward, 1997).

- **Sound pressure level (SPL) by itself is not a good predictor of onset-TTS**, since the amount of TTS depends on both SPL and duration.
- **Exposure energy flux density level (EL) is correlated with the amount of TTS** and is a good predictor for onset-TTS from single, continuous exposures with variable durations. This agrees with human TTS data presented by Ward et al. (1958, 1959).

The most relevant TTS data for analyzing the effects of mid-frequency sonars are from Schlundt et al. (2000, 2006) and Finneran et al. (2005). These studies point to an energy flux density level of 195 dB re 1 μPa^2-s as the most appropriate predictor for onset-TTS in dolphins and belugas from a single, continuous exposure in the mid-frequency range. This finding is supported by the recommendations of a panel of scientific experts formed to study the effects of sound on marine mammals (Southall et al., 2007).

Research by Kastak et al. (1999a; 2005) provided estimates of the average SEL (EFD level) for onset-TTS for a harbor seal, sea lion, and Northern Elephant seal. Although the duration for exposure sessions duration is well beyond those typically used with tactical sonars, the frequency ranges are similar (2.5 kHz to 3.5 kHz). This data provides good estimates for the onset of TTS in pinnipeds since the researchers tested different combinations of SPL and exposure duration, and plotted the growth of TTS with an increasing energy exposure level. Of the three pinniped groups studied by Kastak et al., harbor seals are the most representative of other pinnipeds likely to be present in the Study Area. The onset-TTS number, provided by Kastak et al. for harbor seals, is 183 dB re 1 μPa^2-s.

In contrast to TTS data, PTS data do not exist and are unlikely to be obtained for marine mammals. Differences in auditory structures and the way that sound propagates and interacts with tissues prevent terrestrial mammal PTS thresholds from being directly applied to marine mammals; however, the inner ears of marine mammals are analogous to those of terrestrial mammals. Experiments with marine mammals have revealed similarities between marine and terrestrial mammals with respect to features such as TTS, age-related hearing loss, ototoxic drug-induced hearing loss, masking, and frequency selectivity. Therefore, in the absence of marine mammal PTS data, onset-PTS exposure levels may be estimated from marine mammal TTS data and PTS/TTS relationships observed in terrestrial mammals. This involves:

- Estimating the largest amount of TTS that may be induced without PTS. Exposures causing a TS greater than this value are assumed to cause PTS.
- Estimating the additional exposure, above the onset-TTS exposure, necessary to reach the maximum allowable amount of TTS (assumed here to indicate PTS). This requires estimating the growth rate of TTS – how much additional TTS is produced by an increase in exposure level.

A variety of terrestrial mammal data sources indicate that TSs up to 40 to 50 dB may be induced without PTS, and that 40 dB is a reasonable upper limit for TS to prevent PTS (Ward et al., 1958, 1959, 1960; Miller et al., 1963; Kryter et al., 1966). A conservative assumption is that continuous-type exposures producing TSs of 40 dB or more always result in some amount of PTS.

The TTS growth rate as a function of exposure EL is nonlinear; the growth rate at small amounts of TTS is less than the growth rate at larger amounts of TTS. In other words, the curve relating TTS and EL is not a straight line but a curve that becomes steeper as EL and TTS increase. This means that the relatively small amounts of TTS produced in marine mammal studies limit the applicability of these data to estimate the TTS growth rate — since the amounts of TTS are generally small the TTS growth rate estimates would likely be too low. Fortunately, data exist for the growth of TTS in terrestrial mammals at higher amounts of TTS. Data from Ward et al. (1958, 1959) reveal a linear relationship between TTS and exposure EL with growth rates of 1.5 to 1.6 dB TTS per dB increase in EL. Since there is a 34 dB TS difference between onset-TTS (6 dB) and onset-PTS (40 dB), the additional exposure above onset-TTS that is required to reach PTS would be 34 dB divided by 1.6 dB, or approximately 20 dB. Therefore, exposures with ELs 20 dB above those producing TTS may be assumed to produce a PTS. For an onset-TTS exposure with EL = 195 dB re 1 μPa^2-s, the estimate for onset-PTS for cetaceans would be 215 dB re 1 μPa^2-s. The estimate for onset-PTS threshold for harbor seals would be 203 dB re 1 μPa^2-s. This extrapolation process and the resulting TTS prediction is identical to that recently proposed by a panel of scientific experts formed to study the effects of sound on marine mammals (Southall et al., 2007). The method predicts larger (worse) effects than have actually been observed in tests on a bottlenose dolphin [Schlundt et al. (2006) reported a TTS of 23 dB (no PTS) in a bottlenose dolphin exposed to a 3 kHz tone with an EL = 217 dB re 1 μPa^2-s].

Auditory Trauma

Auditory trauma represents direct mechanical injury to hearing related structures, including tympanic membrane rupture, disarticulation of the middle ear ossicles, and trauma to the inner ear structures such as the organ of Corti and the associated hair cells. The potential for trauma is related to the frequency, duration, onset time and received sound pressure as well as the sensitivity of the animal to the sound frequencies. Because of these interactions, the potential for auditory trauma will vary among species. Auditory trauma is always injurious, but could be temporary and not result in permanent hearing loss. Auditory trauma is always assumed to result in a stress response.

Relatively little is known about auditory system trauma in marine mammals resulting from known sound exposure. A single study spatially and temporally correlated the occurrence of auditory system trauma in humpback whales with the detonation of a 5,000 kg (11,023 lb) explosive (Ketten et al., 1993). The exact magnitude of the exposure in this study cannot be determined and it is possible that the trauma was caused by the shock wave produced by the explosion (which would not be generated by a sonar). There are no known occurrences of direct auditory trauma in marine mammals exposed to tactical sonars.

4.4.3.3.2 Non-Auditory System Response

Potential impacts to tissues other than those related to the auditory system are assessed by considering the characteristics of the sound (e.g., amplitude, frequency, duration) and the known or estimated response characteristics of non-auditory tissues. Some of these assessments can be numerically based (e.g., exposure required for rectified diffusion). Others will be necessarily qualitative, due to lack of information on the mechanical properties of the tissues and their function. Each of the potential responses may or may not result in a stress response.

Direct Tissue Effects

Direct tissue responses to sound stimulation may range from tissue trauma (injury) to mechanical vibration with no resulting injury. Any tissue injury would produce a stress response whereas non-injurious stimulation may or may not.

Resonance is a phenomenon that exists when an object is vibrated at a frequency near its natural frequency of vibration, or the particular frequency at which the object vibrates most readily. The size and geometry of an air cavity determine the frequency at which the cavity will resonate. Displacement of the cavity boundaries during resonance has been suggested as a cause of injury. Large displacements have the potential to tear tissues that surround the air space (e.g., lung tissue).

Understanding resonant frequencies and the susceptibility of marine mammal air cavities to resonance is important in determining whether certain sonars have the potential to affect different cavities in different species. In 2002, NMFS convened a panel of government and private scientists to address this issue (NOAA, 2002b). They modeled and evaluated the likelihood that Navy mid-frequency sonars caused resonance effects in beaked whales that eventually led to their stranding (DoC and DON, 2001). The conclusions of that group were that resonance in air-filled structures was not likely to have caused the Bahamas stranding (NOAA, 2002b). The frequencies at which resonance was predicted to occur were below the frequencies utilized by the sonar systems employed. Furthermore, air cavity vibrations, even at resonant frequencies, were not considered to be of sufficient amplitude to cause tissue damage, even under the worst-case scenario in which air volumes would be undamped by surrounding tissues and the amplitude of the resonant response would be maximal. These same conclusions would apply to other actions involving mid-frequency tactical sonar.

Indirect Tissue Effects

Based upon the amplitude, frequency, and duration of the sound, it must be assessed whether exposure is sufficient to indirectly affect tissues. For example, one suggested (indirect) cause of injury to marine mammals is rectified diffusion (Crum and Mao, 1996), the process of increasing the size of a bubble by exposing it to a sound field. Under this hypothesis, one of three things could happen: (1) bubbles grow to the extent that tissue hemorrhage (injury) occurs; (2) bubbles develop to the extent that a complement immune response is triggered or the nervous tissue is subjected to enough localized pressure that pain or dysfunction occurs (a stress response without injury); or (3) the bubbles are cleared by the lung without negative consequence to the animal. The probability of rectified diffusion, or any other indirect tissue effect, will necessarily be based upon what is known about the specific process involved.

Rectified diffusion is facilitated if the environment in which the ensonified bubbles exist is supersaturated with gas. Repetitive diving by marine mammals can cause the blood and some tissues to accumulate gas to a greater degree than is supported by the surrounding environmental pressure (Ridgway and Howard, 1979). The dive patterns of some marine mammals (for example, beaked whales) are theoretically predicted to induce greater supersaturation (Houser et al., 2001b). If rectified diffusion were possible in marine mammals exposed to high-level sound, conditions of tissue supersaturation could theoretically speed the rate and increase the size of bubble growth. Subsequent effects due to tissue trauma and emboli would presumably mirror those observed in humans suffering from decompression sickness (DCS).

It is unlikely that the short duration of sonar pings would be long enough to drive bubble growth to any substantial size, if such a phenomenon occurs. However, an alternative but related hypothesis has also been suggested: stable microbubbles could be destabilized by high-level sound exposures such that bubble growth then occurs through static diffusion of gas out of the tissues. In such a scenario, the marine mammal would need to be in a gas-supersaturated state for a long enough period of time for bubbles to become of a problematic size.

Recent research with *ex vivo* supersaturated tissues suggested that sound exposures of approximately 215 dB re 1 μPa would be required before microbubbles became destabilized and grew (Crum et al. 2005). Assuming spherical spreading loss and a nominal sonar source level of 235 dB re 1 μPa, a whale would need to be within 10 m (33 ft) of the sonar dome to be exposed to such sound levels. Furthermore, tissues were supersaturated by exposing them to pressures of 400 to 700 kPa for periods of hours and then releasing them to ambient pressures. Assuming the equilibration of gases with the tissues occurred when the tissues were exposed to the high pressures, levels of supersaturation in the tissues could have been as high as 400 to 700 percent. These levels of tissue supersaturation are substantially higher than model predictions for marine mammals (Houser et al., 2001b). It is improbable that this mechanism is responsible for stranding events or traumas associated with beaked whale strandings. Both the degree of supersaturation and exposure levels observed to cause microbubble destabilization are unlikely to occur, either alone or in concert.

Yet another hypothesis has speculated that rapid ascent to the surface following exposure to a startling sound might produce tissue gas saturation sufficient for the evolution of nitrogen bubbles (Jepson et al., 2003; Fernandez et al., 2005). This is accounted for in the conceptual framework via a feedback path from the behavioral changes of “diving” and “avoidance” to the “indirect tissue response” block. In this scenario, the rate of ascent would need to be sufficiently rapid to compromise behavioral or physiological protections against nitrogen bubble formation. Recent modeling suggests that unrealistically rapid rates of ascent from normal dive behaviors are unlikely to result in supersaturation to the extent that bubble formation would be expected in beaked whales (Zimmer et al., 2007). Recently, Tyack et al. (2006) suggested that emboli observed in animals exposed to mid-frequency range sonar (Jepson et al., 2003; Fernandez et al., 2005) could stem instead from a behavioral response that involves repeated dives shallower than the depth of lung collapse. Given that nitrogen gas accumulation is a passive process (i.e. nitrogen is metabolically inert), a bottlenose dolphin was trained to repetitively dive a profile predicted to elevate nitrogen saturation to the point that nitrogen bubble formation was predicted to occur. However, inspection of the vascular system of the dolphin via ultrasound did not demonstrate the formation of even asymptomatic nitrogen gas bubbles (Houser et al., 2007).

There is considerable disagreement among scientists as to the likelihood of this phenomenon (Piantadosi and Thalmann, 2004; Evans and Miller, 2003). Although it has been argued that traumas from recent beaked whale strandings are consistent with gas emboli and bubble-induced tissue separations (Jepson et al., 2003; Fernandez et al., 2005), nitrogen bubble formation as the cause of the traumas has not been verified. The presence of bubbles postmortem, particularly after decompression, is not necessarily indicative of bubble pathology. Prior experimental work has demonstrated the post-mortem presence of bubbles following decompression in laboratory animals can occur as a result of invasive investigative procedures (Stock et al., 1980). Additionally, the fat embolic syndrome identified by Fernández et al. (2005) is the first of its kind. The pathogenesis of fat emboli formation is as yet undetermined and remains largely unstudied, and it would therefore be inappropriate to causally link it to nitrogen bubble formation. Because evidence of nitrogen bubble formation following a rapid ascent by beaked whales is arguable and requires further investigation, this EIS/OEIS makes no assumptions about it being the causative mechanism in beaked whale strandings associated with sonar operations. No similar findings to those found in beaked whales stranding coincident with sonar activity have been reported in other stranded animals following known exposure to sonar operations. By extension, no marine mammals addressed in this EIS/OEIS are given differential treatment due to the possibility for acoustically mediated bubble growth.

No Tissue Effects

The received sound is insufficient to cause either direct (mechanical) or indirect effects to tissues. No stress response occurs.

4.4.3.3.3 The Stress Response

The acoustic source is considered a potential stressor if, by its action on the animal, via auditory or nonauditory means, it may produce a stress response in the animal. The term "stress" has taken on an ambiguous meaning in the scientific literature, but with respect to Figure 4-1 and the later discussions of allostasis and allostatic loading, the stress response will refer to an increase in energetic expenditure that results from exposure to the stressor and which is predominantly characterized by either the stimulation of the sympathetic nervous system (SNS) or the hypothalamic-pituitary-adrenal (HPA) axis (Reeder and Kramer, 2005), or through oxidative stress, as occurs in noise-induced hearing loss (Henderson et al., 2006). The SNS response to a stressor is immediate and acute and is characterized by the release of the catecholamine neurohormones norepinephrine and epinephrine (i.e., adrenaline). These hormones produce elevations in the heart and respiration rate, increase awareness, and increase the availability of glucose and lipids for energy. The HPA response is ultimately defined by increases in the secretion of the glucocorticoid steroid hormones, (e.g. cortisol, aldosterone).. The amount of increase in circulating glucocorticoids above baseline may be an indicator of the overall severity of a stress response (Hennessy et al., 1979). Each component of the stress response is variable in time; e.g., adrenalines are released nearly immediately and are used or cleared by the system quickly, whereas cortisol levels may take long periods of time to return to baseline.

The presence and magnitude of a stress response in an animal depends on a number of factors. These include the animal's life history stage (e.g., neonate, juvenile, and adult), the environmental conditions, reproductive or developmental state, and experience with the stressor. Not only will these factors be subject to individual variation, but they will also vary within an individual over time. Prior experience with a stressor may be of particular importance as repeated experience with a stressor may dull the stress response via acclimation (St. Aubin and Dierauf, 2001). In considering potential stress responses of marine mammals to acoustic stressors, each of these should be considered. For example, is the acoustic stressor in an area where animals engage in breeding activity? Are animals in the region resident and likely to have experience with the stressor (i.e., repeated exposures)? Is the region a foraging ground or are the animals passing through as transients? What is the ratio of young (naïve) to old (experienced) animals in the population? It is unlikely that all such questions can be answered from empirical data; however, they should be addressed in any qualitative assessment of a potential stress response as based on the available literature.

Marine mammals naturally experience stressors within their environment and as part of their life histories. Changing weather and ocean conditions, exposure to diseases and naturally occurring toxins, lack of prey availability, social interactions with conspecifics, and interactions with predators all contribute to the stress a marine mammal experiences. In some cases, naturally occurring stressors can have profound impacts on marine mammals; for example, chronic stress, as observed in stranded animals with long-term debilitating conditions (e.g., disease), has been demonstrated to result in an increased size of the adrenal glands and an increase in the number of epinephrine-producing cells (Clark et al., 2006). Anthropogenic activities have the potential to provide additional stressors above and beyond those that occur naturally. Potential stressors resulting from anthropogenic activities must be considered not only as to their direct impact on the animal but also as to their cumulative impact with environmental stressors already experienced by the animal.

Studies on the stress response of odontocete cetaceans to acute acoustic stimuli were previously discussed Thomas et al., 1990; Miksis et al., 2001; Romano et al., 2004). Other types of stressors include the presence of vessels, fishery interactions, acts of pursuit and capture, the act of stranding, and pollution. In contrast to the limited amount of work performed on stress responses resulting from sound exposure, a considerably larger body of work exists on stress responses associated with pursuit, capture, handling and stranding. Pursuit, capture and short-term holding of belugas has been observed to result in a decrease in thyroid hormones (St. Aubin and Geraci, 1988) and increases in epinephrine (St. Aubin and Dierauf, 2001). In dolphins, the trend is more complicated with the duration of the handling time potentially contributing to the magnitude of the stress response (St. Aubin et al., 1996; Ortiz and Worthy, 2000; St. Aubin, 2002). Elephant seals demonstrate an acute cortisol response to handling, but do not demonstrate a chronic response; on the contrary, adult females demonstrate a reduction in the adrenocortical response following repetitive chemical immobilization (Engelhard et al., 2002). With respect to anthropogenic sound as a stressor, the current limited body of knowledge will require extrapolation from species for which information exists to those for which no information exists.

The stress response may or may not result in a behavioral change**,** depending on the characteristics of the exposed animal. However, provided a stress response occurs, we assume that some contribution is made to the animal's allostatic load. Allostasis is the ability of an animal to maintain stability through change by adjusting its physiology in response to both predictable and unpredictable events (McEwen and Wingfield, 2003). The same hormones associated with the stress response vary naturally throughout an animal's life, providing support for particular life history events (e.g., pregnancy) and predictable environmental conditions (e.g., seasonal changes). The allostatic load is the cumulative cost of allostasis incurred by an animal and is generally characterized with respect to an animal's energetic expenditure. Perturbations to an animal that may occur with the presence of a stressor, either biological (e.g., predator) or anthropogenic (e.g., construction), can contribute to the allostatic load (Wingfield, 2003). Additional costs are cumulative and additions to the allostatic load over time may contribute to reductions in the probability of achieving ultimate life history functions (e.g., survival, maturation, reproductive effort and success) by producing pathophysiological states. The contribution to the allostatic load from a stressor requires estimating the magnitude and duration of the stress response, as well as any secondary contributions that might result from a change in behavior.

If the acoustic source does not produce tissue effects, is not perceived by the animal, or does not produce a stress response by any other means, Figure 4-1 assumes that the exposure does not contribute to the allostatic load. Additionally, without a stress response or auditory masking, it is assumed that there can be no behavioral change. Conversely, any immediate effect of exposure that produces an injury (i.e., red boxes on the flow chart in Figure 4-1) is assumed to also produce a stress response and contribute to the allostatic load.

4.4.3.4 Behavior Block

Acute stress responses may or may not cause a behavioral reaction. However, all changes in behavior are expected to result from an acute stress response. This expectation is conservatively based on the assumption that some sort of physiological trigger must exist for an anthropogenic stimulus to alter a biologically significant behavior that is already being performed. The exception to this rule is the case of masking. The presence of a masking sound may not produce a stress response, but may interfere with the animal’s ability to detect and discriminate biologically relevant signals. The inability to detect and discriminate biologically relevant signals hinders the potential for normal behavioral responses to auditory cues and is thus considered a behavioral change.

Numerous behavioral changes can occur as a result of stress response, and Figure 4-1 lists only those that might be considered the most common types of response for a marine animal. For each potential behavioral change, the magnitude in the change and the severity of the response needs to be estimated. Certain conditions, such as a flight response might have a probability of resulting in injury. For example, a flight response, if significant enough, could produce a stranding event. Under the MMPA, such an event precipitated by anthropogenic noise would be considered a Level A harassment. Each altered behavior may also have the potential to disrupt biologically significant events (e.g., breeding or nursing) and may need to be qualified as Level B harassment. All behavioral disruptions have the potential to contribute to the allostatic load. This secondary potential is signified by the feedback from the collective behaviors to allostatic loading (physiology block).

The response of a marine mammal to an anthropogenic sound source will depend on the frequency content, duration, temporal pattern and amplitude of the sound as well as the animal’s prior experience with the sound and the context in which the sound is encountered (i.e., what the animal is doing at the time of the exposure). The direction of the responses can vary, with some changes resulting in either increases or decreases from baseline (e.g., decreased dive times and increased respiration rate). Responses can also overlap; for example, an increased respiration rate is likely to be coupled to a flight response. Differential responses between and within species are expected since hearing ranges vary across species and the behavioral ecology of individual species is unlikely to completely overlap.

A review of marine mammal responses to anthropogenic sound was first conducted by Richardson and others in 1995. A more recent review (Nowacek et al., 2007) addresses studies conducted since 1995 and focuses on observations where the received sound level of the exposed marine mammal(s) was known or could be estimated. The following sections provide a very brief overview of the state of knowledge of behavioral responses. The overviews focus on studies conducted since 2000 but are not meant to be comprehensive; rather, they provide an idea of the variability in behavioral responses that would be expected given the differential sensitivities of marine mammal species to sound and the wide range of potential acoustic sources to which a marine mammal may be exposed. Estimates of the types of behavioral responses that could occur for a given sound exposure should be determined from the literature that is available for each species, or extrapolated from closely related species when no information exists.

<u>Flight Response</u> – A flight response is a dramatic change in normal movement to a directed and rapid movement away from the perceived location of a sound source. Relatively little information on flight responses of marine mammals to anthropogenic signals exists, although observations of flight responses to the presence of predators have occurred (Connor and Heithaus, 1996). Flight responses have been speculated as being a component of marine mammal strandings associated with sonar activities (Evans and England, 2001).

<u>Response to Predator</u> – Evidence suggests that at least some marine mammals have the ability to acoustically identify potential predators. For example, harbor seals that reside in the coastal waters off British Columbia are frequently targeted by certain groups of killer whales, but not others. The seals discriminate between the calls of threatening and non-threatening killer whales (Deecke et al., 2002), a capability that should increase survivorship while reducing the energy required for attending to and responding to all killer whale calls. The occurrence of masking or hearing impairment provides a means by which marine mammals may be prevented from responding to the acoustic cues produced by their predators. Whether or not this is a possibility depends on the duration of the masking/hearing impairment and the likelihood of encountering a predator during the time that predator cues are impeded.

<u>Diving</u> – Changes in dive behavior can vary widely. They may consist of increased or decreased dive times and surface intervals as well as changes in the rates of ascent and descent during a dive. Variations in dive behavior may reflect interruptions in biologically significant activities (e.g., foraging) or they may be of little biological significance. Variations in dive behavior may also expose an animal to potentially harmful conditions (e.g., increasing the chance of ship-strike) or may serve as an avoidance response that enhances survivorship. The impact of a variation in diving resulting from an acoustic exposure depends on what the animal is doing at the time of the exposure and the type and magnitude of the response.

Nowacek et al. (2004) reported disruptions of dive behaviors in foraging North Atlantic right whales when exposed to an alerting stimulus, an action, they noted, that could lead to an increased likelihood of ship strike. However, the whales did not respond to playbacks of either right whale social sounds or vessel noise, highlighting the importance of the sound characteristics in producing a behavioral reaction. Conversely, Indo-Pacific humpback dolphins have been observed to dive for longer periods of time in areas where vessels were present and/or approaching (Ng and Leung, 2003). In both of these studies, the influence of the sound exposure cannot be decoupled from the physical presence of a surface vessel, thus complicating interpretations of the relative contribution of each stimulus to the response. Indeed, the presence of surface vessels, their approach and speed of approach, seemed to be significant factors in the response of the Indo-Pacific humpback dolphins (Ng and Leung, 2003). Low frequency signals of the Acoustic Thermometry of Ocean Climate (ATOC) sound source were not found to affect dive times of humpback whales in Hawaiian waters (Frankel and Clark, 2000) or to overtly affect elephant seal dives (Costa et al., 2003). They did, however, produce subtle effects that varied in direction and degree among the individual seals, illustrating the equivocal nature of behavioral effects and consequent difficulty in defining and predicting them.

Due to past incidents of beaked whale strandings associated with sonar operations, feedback paths are provided between avoidance and diving and indirect tissue effects. This feedback accounts for the hypothesis that variations in diving behavior and/or avoidance responses can possibly result in nitrogen tissue supersaturation and nitrogen off-gassing, possibly to the point of deleterious vascular bubble formation (Jepson et al., 2003). Although hypothetical, the potential process is being debated within the scientific community.

<u>Foraging</u> - Disruption of feeding behavior can be difficult to correlate with anthropogenic sound exposure, so it is usually inferred by observed displacement from known foraging areas, the appearance of secondary indicators (e.g., bubble nets or sediment plumes), or changes in dive behavior. Noise from seismic surveys was not found to impact the feeding behavior in western gray whales off the coast of Russia (Yazvenko et al., 2007) and sperm whales engaged in foraging dives did not abandon dives when exposed to distant signatures of seismic airguns (Madsen et al., 2006). Balaenopterid whales exposed to moderate low-frequency signals similar to the ATOC sound source demonstrated no variation in foraging activity (Croll et al., 2001), whereas five out of six North Atlantic right whales exposed to an acoustic alarm interrupted their foraging dives (Nowacek et al., 2004). Although the received sound pressure level at the animals was similar in the latter two studies, the frequency, duration, and temporal pattern of signal presentation were different. These factors, as well as differences in species sensitivity, are likely contributing factors to the differential response. A determination of whether foraging disruptions incur fitness consequences will require information on or estimates of the energetic requirements of the individuals and the relationship between prey availability, foraging effort and success, and the life history stage of the animal.

<u>Breathing</u> – Variations in respiration naturally vary with different behaviors and variations in respiration rate as a function of acoustic exposure can be expected to co-occur with other behavioral reactions, such as a flight response or an alteration in diving. However, respiration rates in and of themselves may be representative of annoyance or an acute stress response. Mean exhalation rates of gray whales at rest and while diving were found to be unaffected by seismic surveys conducted adjacent to the whale feeding grounds (Gailey et al., 2007). Studies with captive harbor porpoises showed increased respiration rates upon introduction of acoustic alarms (Kastelein et al., 2000; Kastelein et al., 2006a) and emissions for underwater data transmission (Kastelein et al., 2005). However, exposure of the same acoustic alarm to a striped dolphin under the same conditions did not elicit a response (Kastelein et al., 2006a), again highlighting the importance in understanding species differences in the tolerance of underwater noise when determining the potential for impacts resulting from anthropogenic sound exposure.

Social relationships - Social interactions between mammals can be affected by noise via the disruption of communication signals or by the displacement of individuals. Disruption of social relationships therefore depends on the disruption of other behaviors (e.g., caused avoidance, masking, etc.) and no specific overview is provided here. However, social disruptions must be considered in context of the relationships that are affected. Long-term disruptions of mother/calf pairs or mating displays have the potential to affect the growth and survival or reproductive effort/success of individuals, respectively.

Vocalizations - Vocal changes in response to anthropogenic noise can occur across the repertoire of sound production modes used by marine mammals, such as whistling, echolocation click production, calling, and singing. Changes may result in response to a need to compete with an increase in background noise or may reflect an increased vigilance or startle response. For example, in the presence of low-frequency active sonar, humpback whales have been observed to increase the length of their "songs" (Miller et al., 2000; Fristrup et al., 2003), possibly due to the overlap in frequencies between the whale song and the low-frequency active sonar. A similar compensatory effect for the presence of low frequency vessel noise has been suggested for right whales; right whales have been observed to shift the frequency content of their calls upward while reducing the rate of calling in areas of increased anthropogenic noise (Parks et al., 2007). Killer whales off the northwestern coast of the United States have been observed to increase the duration of primary calls once a threshold in observing vessel density (e.g., whale watching) was reached, which has been suggested as a response to increased masking noise produced by the vessels (Foote et al., 2004). In contrast, both sperm and pilot whales potentially ceased sound production during the Heard Island feasibility test (Bowles et al., 1994), although it cannot be absolutely determined whether the inability to acoustically detect the animals was due to the cessation of sound production or the displacement of animals from the area.

Avoidance - Avoidance is the displacement of an individual from an area as a result of the presence of a sound. It is qualitatively different from the flight response in its magnitude (i.e., directed movement, rate of travel, etc.). Oftentimes avoidance is temporary, and animals return to the area once the noise has ceased. Longer term displacement is possible, however, which can lead to changes in abundance or distribution patterns of the species in the affected region if they do not become acclimated to the presence of the sound (Blackwell et al., 2004; Bejder et al., 2006; Teilmann et al., 2006). Acute avoidance responses have been observed in captive porpoises and pinnipeds exposed to a number of different sound sources (Kastelein et al., 2000; Finneran et al., 2003; Kastelein et al., 2006a; Kastelein et al., 2006b). Short term avoidance of seismic surveys, low frequency emissions, and acoustic deterrents has also been noted in wild populations of odontocetes (Bowles et al., 1994; Goold, 1996; 1998; Stone et al., 2000; Morton and Symonds, 2002) and to some extent in mysticetes (Gailey et al., 2007), while longer term or repetitive/chronic displacement for some dolphin groups and for manatees has been suggested to be due to the presence of chronic vessel noise (Haviland-Howell et al., 2007; Miksis-Olds et al., 2007).

Orientation - A shift in an animal's resting state or an attentional change via an orienting response represent behaviors that would be considered mild disruptions if occurring alone, and thus are placed at the bottom of the framework behavior list. As previously mentioned, the responses may co-occur with other behaviors; for instance, an animal may initially orient toward a sound source, and then move away from it. Thus, any orienting response should be considered in context of other reactions that may occur.

4.4.3.5 Life Function

Proximate life history functions are the functions that the animal is engaged in at the time of acoustic exposure. The disruption of these functions, and the magnitude of the disruption, is something that must be considered in determining how the ultimate life history functions are affected. Consideration of the magnitude of the effect to each of the proximate life history functions is dependent upon the life stage of the animal. For example, an animal on a breeding ground which is sexually immature will suffer relatively little consequence to disruption of breeding behavior when compared to an actively displaying adult of prime reproductive age.

The ultimate life functions are those that enable an animal to contribute to the population (or stock, or species, etc.) and which related to the animal's *fitness*. The impact to ultimate life functions will depend on the nature and magnitude of the perturbation to proximate life history functions. Depending on the severity of the response to the stressor, acute perturbations may have nominal to profound impacts on ultimate life functions. For example, unit-level use of sonar by a vessel transiting through an area that is utilized for foraging, but not for breeding, may disrupt feeding by exposed animals for a brief period of time. Because of the brevity of the perturbation, the impact to ultimate life functions may be negligible. By contrast, weekly training over a period of years may have a more substantial impact because the stressor is chronic. Assessment of the magnitude of the stress response from the chronic perturbation would require an understanding of how and whether animals acclimate to a specific, repeated stressor and whether chronic elevations in the stress response (e.g., cortisol levels) produce fitness deficits.

The proximate life functions are loosely ordered in decreasing severity of impact. Mortality (survival) has an immediate effect, in that no future reproductive success is feasible and there is no further addition to the population resulting from reproduction. Severe injuries may also lead to reduced survivorship (longevity) and prolonged alterations in behavior. The latter may further affect an animal's overall reproductive success and reproductive effort. Disruptions of breeding have an immediate impact on reproductive effort and may impact reproductive success. The magnitude of the effect will depend on the duration of the disruption and the type of behavior change that was provoked. Disruptions to feeding and migration can affect all of the ultimate life functions; however, the impacts to reproductive effort and success are not likely to be as severe or immediate as those incurred by mortality and breeding disruptions.

4.4.4 The Regulatory Framework

To complete the acoustic effects analysis, the **conceptual framework** (Section 4.4.3) must be related to the existing **regulatory frameworks** of the ESA and MMPA. The following sections describe the relationship between analyses conducted within the conceptual framework and regulations established by the MMPA and ESA.

4.4.4.1 MMPA Harassment

For military readiness activities, **MMPA Level A harassment** includes any act that injures or has the significant potential to injure a marine mammal or marine mammal stock in the wild.

Injury, as defined in this EIS/OEIS and previous rulings (NOAA, 2001, 2002a), is the destruction or loss of biological tissue. Consistent with prior actions and rulings (NOAA, 2001), this EIS/OEIS assumes that all injuries (slight to severe) are considered Level A harassment under the MMPA.

For military readiness activities, **MMPA Level B harassment** includes all actions that disturb or are likely to disturb a marine mammal or marine mammal stock in the wild through the disruption of natural behavioral patterns including, but not limited to, migration, surfacing, nursing, breeding, feeding, or sheltering to a point where such behavioral patterns are abandoned or significantly altered.

Some physiological responses to sound exposure can occur that are non-injurious but that can potentially disrupt the behavior of a marine mammal. These include temporary distortions in sensory tissue that alter physiological function, but that are fully recoverable without the requirement for tissue replacement or regeneration. For example, an animal that experiences a TTS suffers no injury to its auditory system, but may not perceive some sounds due to the reduction in sensitivity. As a result, the animal may not respond to sounds that would normally produce a behavioral reaction. This lack of response qualifies as a temporary disruption of normal behavioral patterns – the animal is impeded from responding in a normal manner to an acoustic stimulus. This EIS/OEIS assumes that all TTS (slight to severe) is considered Level B harassment, even if the effect from the temporary impairment is biologically insignificant.

The harassment status of slight behavior disruption (without physiological effects as defined in this EIS/OEIS) has been addressed in workshops, previous actions, and rulings (NOAA, 1999, 2001; DON, 2001a). The conclusion is that a momentary behavioral reaction of an animal to a brief, time-isolated acoustic event does not qualify as Level B harassment. A more general conclusion, that Level B harassment occurs only when there is "a potential for a significant behavioral change or response in a biologically important behavior or activity," is found in recent rulings (NOAA, 2002a). Public Law 108-136 (2004) amended the definition of Level B harassment for military readiness activities, which applies to this action. For military readiness activities, Level B harassment is defined as "any act that disturbs or is likely to disturb a marine mammal or marine mammal stock by causing disruption of natural behavioral patterns…to a point where such behaviors are abandoned or significantly altered." These conclusions and definitions, including the 2004 amendments to the definitions of harassment, were considered in developing conservative thresholds for behavioral disruptions. As a result, the actual incidental harassment of marine mammals associated with this action may be less than calculated.

The volumes of ocean in which Level A and Level B harassment are predicted to occur are described as **harassment zones**. The **Level A harassment zone** extends from the source out to the distance and exposure at which the slightest amount of injury is predicted to occur. The acoustic exposure that produces the slightest degree of injury is therefore the threshold value defining the outermost limit of the Level A harassment zone. Use of the threshold associated with the onset of slight injury as the most distant point and least injurious exposure takes account of all more serious injuries by inclusion within the Level A harassment zone. The threshold used to define the outer limit of the Level A harassment zone is given in Section 4.4.5. The **Level B harassment zone** begins just beyond the point of slightest injury and extends outward from that point to include all animals with the potential to experience Level B harassment. The animals predicted to be in the portion of the zone where temporary impairment of sensory function (altered physiological function) is expected are all assumed to experience Level B harassment because of the potential impediment of behaviors that rely on acoustic cues. Beyond that distance, the Level B harassment zone continues to the point at which no behavioral disruption is expected to occur. The criterion and threshold used to define the outer limit of the Level B harassment zone are given in Section 4.4.5.

Because the tissues of the ear appear to be the most susceptible to the physiological effects of sound and TSs tend to occur at lower exposures than other more serious auditory effects, **PTS and TTS are used in this EIS/OEIS as biological indicators of physiological responses that qualify as harassment**.

PTS is non-recoverable and, by definition, must result from the destruction of tissues within the auditory system. PTS therefore qualifies as an injury and is classified as Level A harassment under the wording of the MMPA. In this EIS/OEIS, the smallest amount of PTS (onset-PTS) is taken to be the indicator for the smallest degree of injury that can be measured. The acoustic exposure associated with **onset-PTS is used to define the outer limit of the Level A harassment zone**.

TTS is recoverable and, as in recent rulings (NOAA 2001, 2002a), is considered to result from the temporary, non-injurious distortion of hearing-related tissues. In this EIS/OEIS, the smallest measurable amount of TTS (onset-TTS) is taken as the best indicator for slight temporary sensory impairment. Because it is considered non-injurious, the acoustic exposure associated with **onset-TTS is used to define the outer limit of the portion of the Level B harassment zone attributable to a physiological impairment, and within which all animals are assumed to incur Level B harassment**. This follows from the concept that hearing loss potentially affects an animal's ability to react normally to the sounds around it. Therefore, in this EIS/OEIS the potential for TTS is considered as a Level B harassment that is mediated by a physiological effect upon the auditory system.

At exposure levels below those which can cause TTS, animals may respond to the sound and alter their natural behaviors. Whether or not these alterations result in "a potential for a significant behavioral change or response in a biologically important behavior or activity" depends on the physical characteristics of the sound (e.g., amplitude, frequency characteristics, temporal pattern, duration, etc.) as well as the animal's experience with the sound, the context of the exposure (e.g., what is the animal doing at the time of the exposure), and the animal's life history stage. Responses will be species-specific and must consider the acoustic sensitivity of the species. In this EIS/OEIS a risk function is used to determine the outer limit of the portion of the Level B harassment zone attributable to significant changes in biologically important behaviors, but which is not a function of TTS. The risk function defines a probability of a significant change in biologically important behaviors as a function of the received sound pressure level. This follows from the concept that the probability of a behavioral response will generally decline as a function of decreasing exposure level.

Figure 4-3 (Summary of the Acoustic Effect Framework Used in This EIS/OEIS) is a visual depiction of the MMPA acoustic effects framework used in this EIS/OEIS. The volumes of ocean in which Level A and Level B harassment are predicted to occur are described as harassment zones. (This figure is intended to illustrate the general relationships between harassment zones and does not represent the sizes or shapes of the actual harassment zones for this EIS/OEIS.) The Level A harassment zone extends from the source out to the distance and exposure where onset-PTS is predicted to occur. The Level B harassment zone begins just beyond the point of onset-PTS and extends outward to the distance and exposure where no (biologically significant) behavioral disruption is expected to occur. The Level B harassment zone includes both the region in which TTS is predicted to occur and the region in which significant behavioral responses without TS are predicted to occur. Criteria and thresholds used to define the outer limits of the Level A and Level B harassment zones are given in Section 4.4.5.

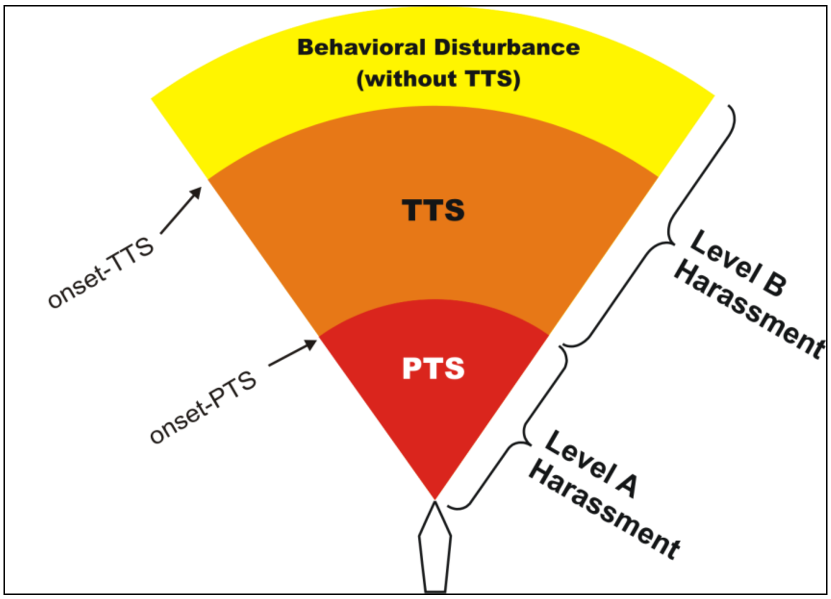


Figure 4-3. Summary of the Acoustic Effect Framework Used in This EIS/OEIS
(This figure is intended to illustrate the general relationships between harassment zones and does not represent the sizes or shapes of the actual harassment zones for this EIS/OEIS.)

4.4.4.2 ESA Harm and Harassment

Sound exposure criteria and thresholds relevant to MMPA regulations were developed using the MMPA Level A and Level B definitions. Regulations established by the ESA establish different criteria for determining impacts to animals covered by the ESA.

- ESA regulations define harm as "an act which actually kills or injures" fish or wildlife (50 CFR 222.102). Based on this definition, the criteria and thresholds developed to estimate MMPA Level A harassment zones are also used to provide an initial assessment of the potential for harm under the ESA. The Level A harassment criterion applied here is the slightest measurable degree of tissue injury. If any ESA-listed marine mammals are predicted to be within the Level A harassment zone, these species are considered to potentially experience ESA harm.

- ESA regulations define harassment as an "intentional or negligent act or omission which creates the likelihood of injury to wildlife by annoying it to such an extent as to significantly disrupt normal behavioral patterns which include, but are not limited to, breeding, feeding, or sheltering" (50 CFR 17.3). Consistent with NMFS Section 7 analyses (e.g. see NMFS 2007), the spatial and temporal overlap of activities with the presence of listed species is assessed. The density and distribution of age, gender, and life history stage of the species present are then considered with respect to the predicted number and types of behavioral reactions expected to occur as a result of the action. The potential for behavioral responses to affect the *fitness* of an individual is then determined; the fitness of the animal is generally related to the animal's relative lifetime reproductive success. Disrupted factors that can impact an animal's fitness include survival, growth, and reproductive effort or success. A reduction in an animal's fitness may have the potential to contribute to an overall reduction in the abundance of a population by affecting the growth rate of the population to which it belongs. In this EIS/OEIS, the risk function for estimating Level B harassment under the MMPA is used to first assess the number of acoustic exposures of marine mammals that could "possibly" affect the fitness of an individual. For each species, the relationship between the exposure values and predicted behavioral responses are then compared against the predicted distribution of age, gender and life history stage of the exposed animals. Next, a determination is made as to whether behavioral responses will have a fitness consequence to the animals. Any behavioral responses that are deemed to have potential fitness consequences are qualified as harassment. Finally, a determination is made as to whether the cumulative cost to the fitness of the individuals is likely to adversely affect the population's viability.

Details of the predicted exposure levels (e.g., number, duration, and sound pressure level of received pings), species density and distribution information, species life history information, and the conceptual biological framework are then consulted to evaluate the potential for harm or harassment as defined in the ESA.

4.4.5 Criteria and Thresholds for MMPA Harassment

4.4.5.1 PTS (Level A) and TTS (Level B)

As discussed previously, the tissues of the ear as being the most susceptible to physiological effects of underwater sound. PTS and TTS were determined to be the most appropriate biological indicators of physiological effects that equate to the onset of injury (Level A harassment) and behavioral disturbance (Level B harassment), respectively. In this EIS/OEIS, sound exposure thresholds for TTS and PTS are:

Cetaceans:

195 dB re 1 μPa^2-s received EL for TTS

215 dB re 1 μPa^2-s received EL for PTS

Pinnipeds:

183 dB re 1 μPa^2-s received EL for TTS

203 dB re 1 μPa^2-s received EL for PTS

A marine mammal predicted to receive a sound exposure with EL equal to or greater than the PTS threshold is assumed to experience PTS and is counted as a Level A harassment. A marine mammal predicted to receive a sound exposure with EL greater than or equal to the TTS threshold but less than the PTS threshold is assumed to experience TTS and is counted as Level B harassment.

Derivation of Effect Thresholds

The cetacean TTS threshold is primarily based on the cetacean TTS data from Schlundt et al. (2000). Since these tests used short-duration tones similar to sonar pings, they are the most directly relevant data for this EIS/OEIS. The mean exposure EL required to produce onset-TTS in these tests was 195 dB re 1 μPa^2-s. This result is corroborated by the mid-frequency tone data of Finneran et al. (2005) and Schlundt et al. (2006) and the long-duration noise data from Nachtigall et al. (2003, 2004). Together, these data demonstrate that TTS in cetaceans is correlated with the received EL and that onset-TTS exposures are fit well by an equal-energy line passing through 195 dB re 1 μPa^2-s.

The pinniped TTS threshold is based on research by Kastak et al. (1999a; 2005). Although the duration for exposure sessions duration is well beyond those typically used with tactical sonars, the frequency ranges are similar (2.5 kHz to 3.5 kHz). This data provides good estimates for the onset of TTS in pinnipeds since the researchers tested different combinations of SPL and exposure duration, and plotted the growth of TTS with an increasing energy exposure level. The onset-TTS number, provided by Kastak et al. for harbor seals and used to analyze impacts on other seals in this document, is 183 dB re 1 μPa^2-s.

The PTS threshold is based on a 20 dB increase in exposure EL over that required for onset-TTS. The 20 dB value is based on estimates from terrestrial mammal data of PTS occurring at 40 dB or more of TS, and on TS growth occurring at a rate of 1.6 dB/dB increase in exposure EL. This estimate is conservative because (1) 40 dB of TS is actually an upper limit for TTS used to approximate onset-PTS; (2) the 1.6 dB/dB growth rate is the highest observed in the data from Ward et al. (1958, 1959) and larger than that experimentally observed in dolphins; and (3) a bottlenose dolphin exposed to a 3 kHz tone at 217 dB re 1 μPa^2-s experienced only TTS and no permanent effects.

Mysticetes and Odontocetes

Information on auditory function in mysticetes is extremely lacking. Sensitivity to low frequency sound by baleen whales has been inferred from observed vocalization frequencies, observed reactions to playback of sounds, and anatomical analyses of the auditory system. Baleen whales are estimated to hear from 15 Hz to 20 kHz, with good sensitivity from 20 Hz to 2 kHz (Ketten, 1998). Filter-bank models of the humpback whale's ear have been developed from anatomical features of the humpback's ear and optimization techniques (Houser et al., 2001a). The results suggest that humpbacks are sensitive to frequencies between 40 Hz and 16 kHz, but best sensitivity is likely to occur between 100 Hz and 8 kHz. However, absolute sensitivity has not been modeled for any baleen whale species. Furthermore, there is no indication of what sorts of sound exposure produce threshold shifts in these animals.

The criteria and thresholds for PTS and TTS developed for odontocetes in this EIS/OEIS are also used for mysticetes. This generalization is based on the assumption that the empirical data at hand are representative of both groups until data collection on mysticete species shows otherwise. For the frequencies of interest in this EIS/OEIS, there is no evidence that the total amount of energy required to induce onset-TTS and onset-PTS in mysticetes is different than that required for odontocetes.

Use of EL for PTS/TTS Thresholds in this EIS/OEIS

Thresholds for PTS/TTS are expressed in terms of total received EL. Energy flux density is a measure of the flow of sound energy through an area (see Appendix B). Marine and terrestrial mammal data show that, for continuous-type sounds (non-impulsive sounds) of interest in this EIS/OEIS, TTS and PTS are more closely related to the energy in the sound exposure than to the exposure SPL.

The EL for each individual ping is calculated from the following equation:

$$\text{EL} = \text{SPL} + 10\log_{10}(\text{duration})$$

The EL includes both the ping SPL and duration. Longer-duration pings and/or higher-SPL pings will have a higher EL.

If an animal is exposed to multiple pings, the energy flux density in each individual ping is summed to calculate the total EL (see Appendix B). Since mammals exhibit lower TSs from intermittent exposures compared to continuous exposures with the same energy (Ward, 1997), basing the thresholds on the total received EL is a conservative approach for treating multiple pings; in reality, some recovery will occur between pings and lessen the severity of a particular exposure. Therefore, estimates in this EIS/OEIS are conservative because recovery is not taken into account – intermittent exposures are considered equivalent to continuous exposures.

The total EL depends on the SPL, duration, and number of pings received. The TTS and PTS thresholds do not imply any specific SPL, duration, or number of pings. The SPL and duration of each received ping are used to calculate the total EL and determine whether the received EL meets or exceeds the effect thresholds. For example, the TTS threshold would be reached through any of the following exposures:

- A single ping with SPL = 195 dB re 1 µPa and duration = 1 second
- A single ping with SPL = 192 dB re 1 µPa and duration = 2 seconds
- Two pings with SPL = 192 dB re 1 µPa and duration = 1 second
- Two pings with SPL = 189 dB re 1 µPa and duration = 2 seconds.

Previous Use of EL for PTS/TTS

Energy measures have been used as a part of dual criteria for cetacean auditory effects in shock trials, which only involve impulsive-type sounds (DON, 1997, 2001a). These actions used 192 dB re 1 μPa^2-s as a reference point to derive a TTS threshold in terms of EL. A second TTS threshold, based on peak pressure, was also used. If either threshold was exceeded, effect was assumed.

The 192 dB re 1 μPa^2-s reference point differs from the threshold of 195 dB re 1 μPa^2-s used for TTS in this EIS/OEIS. The 192 dB re 1 μPa^2-s value was based on the minimum observed by Ridgway et al. (1997) and Schlundt et al. (2000) during TTS measurements with bottlenose dolphins exposed to 1-second tones. At the time, no impulsive test data for marine mammals were available and the 1-second tonal data were considered to be the best available. The minimum value of the observed range of 192 to 201 dB re 1 μPa^2-s was used to protect against misinterpretation of the sparse data set available. The 192 dB re 1 μPa^2-s value was reduced to 182 dB re 1 μPa^2-s to accommodate the potential effects of pressure peaks in impulsive waveforms.

The additional data now available for onset-TTS in small cetaceans confirm the original range of values and increase confidence in it (Finneran et al., 2005; Nachtigall et al., 2003, 2004; Schlundt et al., 2006). This EIS/OEIS, therefore, uses the more complete data available and the mean value of the entire Schlundt et al. (2000) data set (195 dB re 1 μPa^2-s), instead of the minimum of 192 dB re 1 μPa^2-s. The threshold is applied in this EIS/OEIS as an "all-or-nothing" value, where 100 percent of animals receiving an EL greater than or equal to 195 dB re 1 μPa^2-s are considered to experience TTS. From the standpoint of statistical sampling and prediction theory, the mean is the most appropriate predictor – the "best unbiased estimator" – of the EL at which onset-TTS should occur; predicting the number of harassment incidents in future actions relies (in part) on using the EL at which onset-TTS will most likely occur. When the EL is applied over many pings in each of many sonar exercises, that value will provide the most accurate prediction of the actual number of harassment incidents by onset-TTS over all of those exercises. Use of the minimum value would overestimate the amount of incidental harassment because many animals counted would not have experienced onset-TTS. Further, there is no logical limiting minimum value of the distribution that would be obtained from continued successive testing. Continued testing and use of the minimum would produce more and more erroneous estimates for the "all-or-nothing" threshold for effect.

4.4.5.2 Defining MMPA Level B Behavioral Harassment Using Risk Function

In the Hawaii Range Complex EIS/OEIS, the Navy presented a risk function methodology to assess MMPA Level B behavioral harassment from the effects of mid-frequency active sonar on marine mammals. Based on comments received from the public and regulators on the Draft EIS/OEIS, the Navy now presents a more concise mathematical representation of a risk assessment to define behavioral harassment under the MMPA. This AFAST EIS/OEIS explains the approach for assessing MMPA Level B behavioral harassment from the effects of mid-frequency active sonar on marine mammals using the mathematical function previously presented in the Surveillance Towed Array Sensor System Low Frequency Active (SURTASS LFA) EIS (DON, 2001) and relied on in Supplemental SURTASS LFA EIS (DON, 2007) with input parameters modified for mid-frequency active sonar.

4.4.5.3 Summary of Existing Credible Scientific Evidence Relevant to Assessing Behavioral Effects

4.4.5.3.1 Background

Based on available evidence, marine animals are likely to exhibit any of a suite of potential behavioral responses or combinations of behavioral responses upon exposure to sonar transmissions. Potential behavioral responses include, but are not limited to: avoiding exposure or continued exposure; behavioral disturbance (including distress or disruption of social or foraging activity); habituation to the sound; becoming sensitized to the sound; or not responding to the sound.

Existing studies of behavioral effects of human-made sounds in marine environments remain inconclusive, partly because many of those studies have lacked adequate controls, applied only to certain kinds of exposures (which are often different from the exposures being analyzed in the study), and had limited ability to detect behavioral changes that may be significant to the biology of the animals that were being observed. These studies are further complicated by the wide variety of behavioral responses marine mammals exhibit and the fact that those responses can vary significantly by species, individuals, and the context of an exposure. In some circumstances, some individuals will continue normal behavioral activities in the presence of high levels of human-made noise. In other circumstances, the same individual or other individuals may avoid an acoustic source at much lower received levels (Richardson et al., 1995; Wartzok et al., 2003; Southall et al., 2007). These differences within and between individuals appear to result from a complex interaction of experience, motivation, and learning that are difficult to quantify and predict.

It is possible that some marine mammal behavioral reactions to anthropogenic sound may result in strandings. Several “mass stranding” events—strandings that involve two or more individuals of the same species (excluding a single cow-calf pair)—that have occurred over the past two decades have been associated with naval operations, seismic surveys, and other anthropogenic activities that introduced sound into the marine environment. Sonar exposure has been identified as a contributing cause or factor in five specific mass stranding events: Greece in 1996; the Bahamas in March 2000; Madeira Island, Portugal in 2000; the Canary Islands in 2002, and Spain in 2006 (MMC, 2006b).

In these circumstances, exposure to acoustic energy has been considered a potential indirect cause of the death of marine mammals (Cox et al., 2006). A popular hypothesis regarding a potential cause of the strandings is that tissue damage resulting from “gas and fat embolic syndrome” (Fernandez et al., 2005; Jepson et al., 2003; 2005). Models of nitrogen saturation in diving marine mammals have been used to suggest that altered dive behavior might result in the accumulation of nitrogen gas such that the potential for nitrogen bubble formation is increased (Houser et al., 2001b; Zimmer and Tyack, 2007). If so, this mechanism might explain the findings of gas and bubble emboli in stranded beaked whales. It is also possible that stranding is a behavioral response to a sound under certain contextual conditions and that the subsequently observed physiological effects of the strandings (e.g., overheating, decomposition, or internal hemorrhaging from being on shore) were the result of the stranding versus exposure to sonar (Cox et al., 2006).

4.4.5.3.2 Development of the Risk Function

In Section 4.4.6 of the AFAST Draft EIS/OEIS, the Navy presented a risk methodology to assess the probability of MMPA Level B non-TTS behavioral harassment from the effects of mid-frequency and high-frequency active sonar on marine mammals. Following publication of the AFAST Draft EIS/OEIS, the Navy continued working with NMFS to refine the mathematically representative curve previously used, along with applicable input parameters with the purpose of increasing the accuracy of the Navy's assessment. As the regulating and cooperating agency, NMFS presented two methodologies to six scientists (marine mammalogists and acousticians from within and outside the federal government) for an independent review (NMFS, 2008a). Two NMFS scientists, one from NMFS Office of Science and Technology and one from the Office of Protected Resources, then summarized the reviews from the six scientists and developed a recommendation.

One of the methodologies was a normal curve fit to a "mean of means" calculated from the mean of: (1) the estimated mean received level produced by the reconstruction of the USS Shoup event of May 2003 in which killer whales were exposed to mid-frequency active sonar; (2) the mean of the five maximum received levels at which Nowacek et al. (2004) observed significantly different responses of right whales to an alert stimuli; and (3) the mean of the lowest received levels from the 3 kHz data that the SPAWAR Systems Center (SSC) classified as altered behavior from Finneran and Schlundt (2004).

The second methodology was a derivation of a mathematical function used for assessing the percentage of a marine mammal population experiencing the risk of harassment under the MMPA associated with the Navy's use of the SURTASS low-frequency active sonar (DON, 2001). This function is appropriate for application to instances with limited data (Feller, 1968). This methodology is subsequently identified as "the risk function" in this document.

The NMFS Office of Protected Resources made the decision to use the risk function and applicable input parameters to estimate the risk of behavioral harassment associated with exposure to mid-frequency active sonar. This determination was based on the recommendation of the two NMFS scientists; consideration of the independent reviews from six scientists; and NMFS MMPA regulations affecting the Navy's use of SURTASS low-frequency active sonar.

4.4.5.3.3 Methodology for Applying Risk Function

To assess the potential effects on marine mammals associated with active sonar used during training activities, the Navy together with NMFS, as a first step, investigated a series of mathematical models and methodologies that estimate the number of times individuals of the different species of marine mammals might be exposed to mid-frequency active sonar at different received levels. The Navy effects analyses assumed that the potential consequences of exposure to mid-frequency active sonar on individual animals would be a function of the received sound pressure level (dB re 1 μPa). These analyses assume that mid-frequency active sonar poses no risk, that is, does not constitute harassment to marine mammals if they are exposed to sound pressure levels from the mid-frequency active sonar below a certain basement value.

The second step of the assessment procedure requires the Navy and NMFS to identify how marine mammals are likely to respond when they are exposed to active sonar. Marine mammals can experience a variety of responses to sound including sensory impairment (permanent and temporary threshold shifts and acoustic masking), physiological responses (particular stress responses), behavioral responses, social responses that might result in reducing the fitness of individual marine mammals, and social responses that would not result in reducing the fitness of individual marine mammals.

As noted in the prior section, the Navy and NMFS have previously used acoustic thresholds to identify the number of marine mammals that might experience hearing losses (temporary or permanent) or behavioral harassment upon being exposed to mid-frequency active sonar (see Figure 4-4, left panel). These acoustic thresholds have been represented by either sound exposure level (related to sound energy, abbreviated as SEL), sound pressure level (abbreviated as SPL), or other metrics such as peak pressure level and acoustic impulse. The general approach has been to apply these threshold functions so that a marine mammal is counted as behaviorally harassed or experiencing hearing loss when exposed to received sound levels above a certain threshold and not counted as behaviorally harassed or experiencing hearing loss when exposed to received levels below that threshold. For example, previous Navy EISs, environmental assessments, MMPA take authorization requests, and the MMPA incidental harassment authorization (IHA) for the Navy's 2006 RIMPAC Major Exercise (National Oceanic and Atmospheric Administration, 2006i) used 173 decibel re 1 micropascal squared-second (dB re 1 μPa^2-s) as the energy threshold level (i.e., SEL) for Level B behavioral harassment for cetaceans. If the transmitted sonar accumulated energy received by a whale was above 173 dB re 1 μPa^2-s, then the animal was considered to have been behaviorally harassed. If the received accumulated energy level was below 173 dB re 1 μPa^2-s, then the animal was not treated as having been behaviorally harassed.

The left panel in Figure 4-4 illustrates a typical step-function or threshold that might also relate a sonar exposure to the probability of a response. As this figure illustrates, past Navy/NMFS acoustic thresholds assumed that every marine mammal above a particular received level (for example, to the right of the red vertical line in the figure) would exhibit identical responses to a sonar exposure. This assumed that the responses of marine mammals would not be affected by differences in acoustic conditions; differences between species and populations; differences in gender, age, reproductive status, or social behavior; or the prior experience of the individuals.

Both the Navy and NMFS agree that the studies of marine mammals in the wild and in experimental settings do not support these assumptions—different species of marine mammals and different individuals of the same species respond differently to sonar exposure. Additionally, there are specific geographic/bathymetric conditions that dictate the response of marine mammals to sonar that suggest that different populations may respond differently to sonar exposure. Further, studies of animal physiology suggest that gender, age, reproductive status, and social behavior, among other variables, probably affect how marine mammals respond to sonar exposures. (Wartzok et al., 2003; Southall et al., 2007)

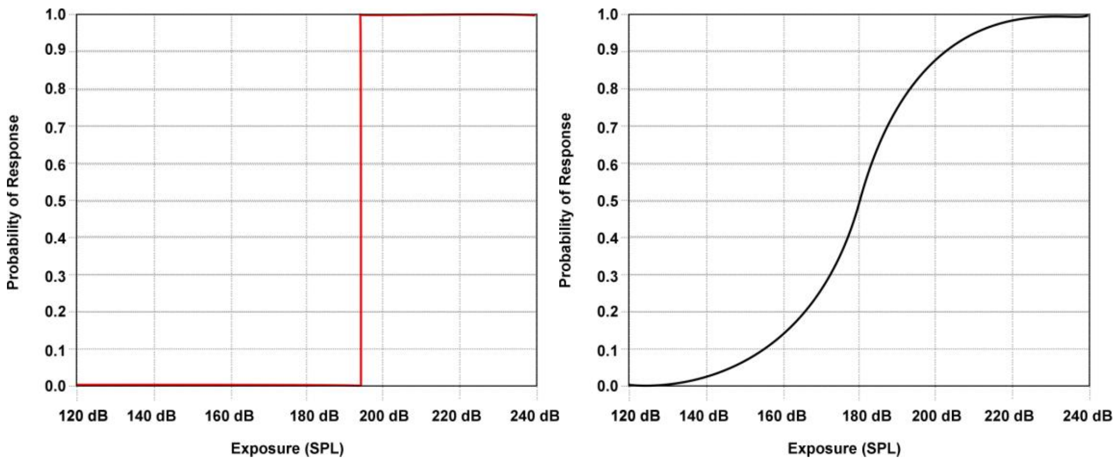


Figure 4-4. Step Function Versus Risk Continuum Function

Note: The left panel illustrates a typical step function with the probability of a response on the y-axis and received exposure on the x-axis. The right panel illustrates a typical risk continuum-function using the same axes. SPL is "Sound Pressure Level" in decibels referenced to 1 micropascal root mean square (1 μPa rms).

Over the past several years, the Navy and NMFS have worked on developing an mid-frequency active sonar acoustic risk function to replace the acoustic thresholds used in the past to estimate the probability of marine mammals being behaviorally harassed by received levels of mid-frequency active sonar. The Navy and NMFS will continue to use acoustic thresholds to estimate temporary or permanent threshold shifts using SEL as the appropriate metric. Unlike acoustic thresholds, acoustic risk continuum functions (which are also called “exposure-response functions,” “dose-response functions,” or “stress-response functions” in other risk assessment contexts) assume that the probability of a response depends first on the “dose” (in this case, the received level of sound) and that the probability of a response increases as the “dose” increases. It is important to note that the probabilities associated with acoustic risk functions do not represent an individual’s probability of responding. Rather, the probabilities identify the proportion of an exposed population that is likely to respond to an exposure.

The right panel in Figure 4-4 illustrates a typical acoustic risk function that might relate an exposure, as received sound pressure level in decibels referenced to 1 μPa, to the probability of a response. As the exposure receive level increases in this figure, the probability of a response increases as well but the relationship between an exposure and a response is “linear” only in the center of the curve (that is, unit increases in exposure would produce unit increases in the probability of a response only in the center of a risk function curve). In the “tails” of an acoustic risk function curve, unit increases in exposure produce smaller increases in the probability of a response. Based on observations of various animals, including humans, the relationship represented by an acoustic risk function is a more robust predictor of the probable behavioral responses of marine mammals to sonar and other acoustic sources.

The Navy and NMFS have previously used the acoustic risk function to estimate the probable responses of marine mammals to acoustic exposures for other training and research programs. Examples of previous application include the Navy FEISs on the SURTASS low-frequency active sonar (DON, 2001); the North Pacific Acoustic Laboratory experiments conducted off the Island of Kauai (DON, 2001b), and the Supplemental EIS for SURTASS low-frequency active sonar (DON, 2007).

The Navy and NMFS used two metrics to estimate the number of marine mammals that could be subject to Level B harassment (behavioral harassment and temporary threshold shift [TTS]) as defined by the MMPA, during training exercises. The agencies used acoustic risk functions with the metric of received sound pressure level (dB re 1 µPa) to estimate the number of marine mammals that might be at risk for MMPA Level B behavioral harassment as a result of being exposed to mid-frequency active sonar. The agencies will continue to use acoustic thresholds ("step-functions") with the metric of sound exposure level (dB re 1 μPa^2-s) to estimate the number of marine mammals that might be "taken" through sensory impairment (i.e., Level A – permanent threshold shift [PTS] and Level B – TTS) as a result of being exposed to mid-frequency active sonar.

Although the Navy has not used acoustic risk functions prior to the Hawaii Range Complex mid-frequency active sonar assessments of the potential effects of mid-frequency active sonar on marine mammals, risk functions are not new concepts for risk assessments. Common elements are contained in the process used for developing criteria for air, water, radiation, and ambient noise and for assessing the effects of sources of air, water, and noise pollution. The Environmental Protection Agency uses dose-functions to develop water quality criteria and to regulate pesticide applications (EPA, 1998a); the Nuclear Regulatory Commission uses dose-functions to estimate the consequences of radiation exposures (see Nuclear Regulatory Commission, 1997 and 10 Code of Federal Regulations 20.1201); the Centers for Disease Control and Prevention and the Food and Drug Administration use dose-functions as part of their assessment methods (for example, see Centers for Disease Control and Prevention, 2003, U.S. Food and Drug Administration and others, 2001); and the Occupational Safety and Health Administration uses dose-functions to assess the potential effects of noise and chemicals in occupational environments on the health of people working in those environments (for examples, see Occupational Safety and Health Administration, 1996; Occupational Safety and Health Administration, 2006).

4.4.5.3.4 Risk Function Adapted from Feller (1968)

The particular acoustic risk function developed by the Navy and NMFS estimates the probability of behavioral responses that NMFS would classify as harassment for the purposes of the MMPA given exposure to specific received levels of mid-frequency active sonar. The mathematical function is derived from a solution in Feller (1968) for the probability as defined in the SURTASS LFA Sonar Final OEIS/EIS (DON, 2001), and relied on in the Supplemental SURTASS LFA Sonar EIS (DON, 2001; 2007) for the probability of mid-frequency active sonar risk for MMPA Level B behavioral harassment with input parameters modified by NMFS for mid-frequency active sonar for mysticetes, odontocetes, and pinnipeds.

In order to represent a probability of risk, the function should have a value near zero at very low exposures, and a value near one for very high exposures. One class of functions that satisfies this criterion is cumulative probability distributions, a type of cumulative distribution function. In selecting a particular functional expression for risk, several criteria were identified:

- The function must use parameters to focus discussion on areas of uncertainty;
- The function should contain a limited number of parameters;

- The function should be capable of accurately fitting experimental data; and
- The function should be reasonably convenient for algebraic manipulations.

As described in DON (2001), the mathematical function below is adapted from a solution in Feller (1968).

$$R = \frac{1 - \left(\frac{L-B}{K}\right)^{-A}}{1 - \left(\frac{L-B}{K}\right)^{-2A}}$$

Where: R = risk (0 – 1.0);
L = Received Level (RL) in dB;
B = basement RL in dB; (120 dB);
K = the RL increment above basement in dB at which there is 50 percent risk;
A = risk transition sharpness parameter (10).

In order to use this function, the values of the three parameters (B, K, and A) need to be established. The values used in this analysis are based on three sources of data: TTS experiments conducted at SSC and documented in Finneran, et al., (2001, 2003, and 2005; Finneran and Schlundt, 2004); reconstruction of sound fields produced by the USS Shoup associated with the behavioral responses of killer whales observed in Haro Strait (DON, 2004e; Fromm, 2004a, 2004b; NMFS, 2005c) and observations of the behavioral response of North Atlantic right whales exposed to alert stimuli containing mid-frequency components documented in Nowacek et al. (2004). The input parameters, as defined by NMFS, are based on very limited data that represent the best available science at this time.

4.4.5.3.5 Data Sources Used For Risk Function

There is widespread consensus that cetacean response to mid-frequency active sound signals needs to be better defined using controlled experiments (Cox et al., 2006; Southall et al., 2007). The Navy is contributing to an ongoing behavioral response study in the Bahamas that is anticipated to provide some initial information on beaked whales, the species identified as the most sensitive to mid-frequency active sonar. NMFS is leading this international effort with scientists from various academic institutions and research organizations to conduct studies on how marine mammals respond to underwater sound exposures.

Until additional data is available, NMFS and the Navy have determined that the following three data sets are most applicable for the direct use in developing risk function parameters for mid-frequency active/high-frequency active sonar. These data sets represent the only known data that specifically relate altered behavioral responses to exposure to mid-frequency active sound sources. Until applicable data sets are evaluated to better qualify harassment from high-frequency active sources, the risk function derived for mid-frequency active sources will apply to high-frequency active sources.

Data from SSC's Controlled Experiments

Most of the observations of the behavioral responses of toothed whales resulted from a series of controlled experiments on bottlenose dolphins and beluga whales conducted by researchers at SSC's facility in San Diego, California (Finneran et al., 2001, 2003, 2005; Finneran and Schlundt 2004; Schlundt et al., 2000). In experimental trials with marine mammals trained to perform tasks when prompted, scientists evaluated whether the marine mammals performed these tasks when exposed to mid-frequency tones. Altered behavior during experimental trials usually involved refusal of animals to return to the site of the sound stimulus. This refusal included what appeared to be deliberate attempts to avoid a sound exposure or to avoid the location of the exposure site during subsequent tests (Schlundt et al., 2000; Finneran et al., 2002). Bottlenose dolphins exposed to 1-sec intense tones exhibited short-term changes in behavior above received sound levels of 178 to 193 dB re 1 μPa root mean square (rms), and beluga whales did so at received levels of 180 to 196 dB and above. Test animals sometimes vocalized after an exposure to impulsive sound from a seismic watergun (Finneran et al., 2002). In some instances, animals exhibited aggressive behavior toward the test apparatus (Ridgway et al., 1997; Schlundt et al., 2000).

1. Finneran and Schlundt (2004) examined behavioral observations recorded by the trainers or test coordinators during the Schlundt et al. (2000) and Finneran et al. (2001, 2003, and 2005) experiments featuring 1-second (sec) tones. These included observations from 193 exposure sessions (fatiguing stimulus level greater than 141 dB re 1μPa) conducted by Schlundt et al. (2000) and 21 exposure sessions conducted by Finneran et al. (2001, 2003, 2005). The observations were made during exposures to sound sources at 0.4 kHz, 3 kHz, 10 kHz, 20 kHz, and 75 kHz. The TTS experiments examined by Finneran and Schlundt (2004) are further explained below:

   a. Schlundt et al. (2000) provided a detailed summary of the behavioral responses of trained marine mammals during TTS tests conducted at SSC San Diego with 1-sec tones. Schlundt et al. (2000) reported eight individual TTS experiments. Fatiguing stimuli durations were 1-sec; exposure frequencies were 0.4 kHz, 3 kHz, 10 kHz, 20 kHz, and 75 kHz. The experiments were conducted in San Diego Bay. Because of the variable ambient noise in the bay, low-level broadband masking noise was used to keep hearing thresholds consistent despite fluctuations in the ambient noise. Schlundt et al. (2000) reported that "behavioral alterations," or deviations from the behaviors the animals being tested had been trained to exhibit, occurred as the animals were exposed to increasing fatiguing stimulus levels.

   b. Finneran et al. (2001, 2003, 2005) conducted TTS experiments using tones at 3 kHz. The test method was similar to that of Schlundt et al. (2000) except the tests were conducted in a pool with very low ambient noise level (below 50 dB re 1 μPa/hertz [Hz]), and no masking noise was used. Two separate experiments were conducted using 1-sec tones. In the first, fatiguing sound levels were increased from 160 to 201 dB SPL. In the second experiment, fatiguing sound levels between 180 and 200 dB re 1 μPa were randomly presented.

Data from Studies of Baleen (Mysticetes) Whale Responses

The only mysticete data available resulted from a field experiments in which baleen whales (mysticetes) were exposed to frequency sound ranging in frequency from 50 Hz (ship noise playback) to 4,500 Hz (alert stimulus) (Nowacek et al., 2004). Behavioral reactions to an alert stimulus, consisting of a combination of tones and frequency and amplitude modulated signals ranging in frequency from 500 Hz to 4,500 Hz, was the only portion of the study used to support the risk function input parameters.

2. Nowacek et al. (2004; 2007) documented observations of the behavioral response of North Atlantic right whales exposed to alert stimuli containing mid-frequency components. To assess risk factors involved in ship strikes, a multi-sensor acoustic tag was used to measure the responses of whales to passing ships and experimentally tested their responses to controlled sound exposures, which included recordings of ship noise, the social sounds of conspecifics, and a signal designed to alert the whales. The alert signal was 18 minutes of exposure consisting of three 2-minute signals played sequentially three times over. The three signals had a 60 percent duty cycle and consisted of: (1) alternating 1-sec pure tones at 500 and 850 Hz; (2) a 2-sec logarithmic down-sweep from 4,500 to 500 Hz; and (3) a pair of low (1,500 Hz)-high (2,000 Hz) sine wave tones amplitude modulated at 120 Hz and each 1 sec long. The purposes of the alert signal were (a) to provoke an action from the whales via the auditory system with disharmonic signals that cover the whales estimated hearing range; (b) to maximize the signal to noise ratio (obtain the largest difference between background noise) and c) to provide localization cues for the whale. Five out of six whales reacted to the signal designed to elicit such behavior. Maximum received levels ranged from 133 to 148 dB re 1μPa.

Observations of Killer Whales in Haro Strait in the Wild

In May 2003, killer whales (*Orcinus orca*) were observed exhibiting behavioral responses while the USS Shoup was engaged in mid-frequency active sonar operations in the Haro Strait in the vicinity of Puget Sound, Washington. Although these observations were made in an uncontrolled environment, the sound field associated with the sonar operations had to be estimated, and the behavioral observations were reported for groups of whales, not individual whales, the observations associated with the USS Shoup provide the only data set available of the behavioral responses of wild, non-captive animal upon exposure to the AN/SQS-53 mid-frequency active sonar.

3. U.S. Department of Commerce (NMFS, 2005c); DON (2004e); Fromm (2004a, 2004b) documented reconstruction of sound fields produced by the USS Shoup associated with the behavioral response of killer whales observed in Haro Strait. Observations from this reconstruction included an approximate of 169.3 dB SPL which represents the mean received level at a point of closest approach within a 500 m (1,640 ft) wide area which the animals were exposed. Within that area, the estimated received levels varied from approximately 150 to 180 dB SPL.

4.4.5.3.6 Limitations of the Risk Function Data Sources

There are substantial limitations and challenges to any risk function derived to estimate the probability of marine mammal behavioral responses; these are largely attributable to sparse data. Ultimately there should be multiple functions for different marine mammal taxonomic groups, but the current data are insufficient to support them. The goal is unquestionably that risk functions be based on empirical measurement.

The risk function presented here is based on three data sets that NMFS and the Navy have determined are the best available science at this time. The Navy and NMFS acknowledge each of these data sets has limitations.

While NMFS considers all data sets as being weighted equally in the development of the risk function, the Navy believes the SSC San Diego data are the most rigorous and applicable for the following reasons:

- The data represent the only source of information where the researchers had complete control over and ability to quantify the noise exposure conditions.
- The altered behaviors were identifiable due to long-term observations of the animals.
- The fatiguing noise consisted of tonal exposures with limited frequencies contained in the mid-frequency active sonar bandwidth.

However, the Navy and NMFS do agree that the following are limitations associated with the three data sets used as the basis of the risk function:

- The three data sets represent the responses of only four species: trained bottlenose dolphins and beluga whales, North Atlantic right whales in the wild, and killer whales in the wild.
- None of the three data sets represent experiments designed for behavioral observations of animals exposed to mid-frequency active sonar.
- The behavioral responses of marine mammals that were observed in the wild are based solely on a measured received level of sound exposure; they do not take into consideration (due to minimal or no supporting data):
    - Potential relationships between acoustic exposures and specific behavioral activities (e.g., feeding, reproduction, changes in diving behavior, etc.), variables such as bathymetry, or acoustic waveguides; or
    - Differences in individuals, populations, or species, or the prior experiences, reproductive state, hearing sensitivity, or age of the marine mammal.

<u>SSC San Diego Trained Bottlenose Dolphins and Beluga Data Set:</u>

- The animals were trained animals in captivity; therefore, they may be more or less sensitive than cetaceans found in the wild (Domjan, 1998).
- The tests were designed to measure TTS, not behavior.

- Because the tests were designed to measure TTS, the animals were exposed to much higher levels of sound than the baseline risk function (only two of the total 193 observations were at levels below 160 dB re 1 μPa^2-s).
- The animals were not exposed in the open ocean but in a shallow bay or pool.
- The tones used in the tests were 1-sec pure tones similar to mid-frequency active sonar.

North Atlantic Right Whales in the Wild Data Set:

- The observations of behavioral response were from exposure to an alert signal that contained mid-frequency components but was not similar to a mid-frequency active sonar ping. The alert signal was 18 minutes of exposure consisting of three 2-minute signals played sequentially three times over. The three signals had a 60 percent duty cycle and consisted of: (1) alternating 1-sec pure tones at 500 and 850 Hz; (2) a 2-sec logarithmic down-sweep from 4,500 to 500 Hz; and (3) a pair of low (1,500 Hz)-high (2,000 Hz) sine wave tones amplitude modulated at 120 Hz and each 1-sec long. This 18-minute alert stimulus is in contrast to the average 1-sec ping every 30 sec in a comparatively very narrow frequency band used by military sonar.
- The purpose of the alert signal was, in part, to provoke an action from the whales through an auditory stimulus.

Killer Whales in the Wild Data Set:

- The observations of behavioral harassment were complicated by the fact that there were other sources of harassment in the vicinity (other vessels and their interaction with the animals during the observation).
- The observations were anecdotal and inconsistent. There were no controls during the observation period, with no way to assess the relative magnitude of the any observed response as opposed to baseline conditions.

4.4.5.3.7 Input Parameters for the Risk Function

The values of B, K, and A need to be specified in order to utilize the risk function defined in Section 4.4.5.3.4 previously. The risk continuum function approximates the dose-response function in a manner analogous to pharmacological risk assessment (DON, 2001 [Appendix A]). In this case, the risk function is combined with the distribution of sound exposure levels to estimate aggregate impact on an exposed population

Basement Value for Risk – The B Parameter

The B parameter defines the basement value for risk, below which the risk is so low that calculations are impractical. This 120 dB level is taken as the estimate received level (RL) below which the risk of significant change in a biologically important behavior approaches zero for the mid-frequency active sonar risk assessment. This level is based on a broad overview of the levels at which multiple species have been reported responding to a variety of sound sources, both mid-frequency and other, was recommended by the scientists, and has been used in other publications. The Navy recognizes that for actual risk of changes in behavior to be zero, the signal-to-noise ratio at the animal must also be zero.

The K Parameter

NMFS and the Navy used the mean of the following values to define the midpoint of the function: (1) the mean of the lowest received levels (185.3 dB) at which individuals responded with altered behavior to 3 kHz tones in the SSC data set; (2) the estimated mean received level value of 169.3 dB produced by the reconstruction of the USS Shoup incident in which killer whales exposed to mid-frequency active sonar (range modeled possible received levels: 150 to 180 dB); and (3) the mean of the 5 maximum received levels at which Nowacek et al. (2004) observed significantly altered responses of right whales to the alert stimuli than to the control (no input signal) is 139.2 dB SPL. The arithmetic mean of these three mean values is 165 dB SPL. The value of K is the difference between the value of B (120 dB SPL) and the 50 percent value of 165 dB SPL; therefore, K=45.

Risk Transition – The A Parameter

The A parameter controls how rapidly risk transitions from low to high values with increasing receive level. As A increases, the slope of the risk function increases. For very large values of A, the risk function can approximate a threshold response or step function. NMFS has recommended that Navy use A=10 as the value for odontocetes (except harbor porpoises), and pinnipeds, and A=8 for mysticetes (Figures 4-4 and 4-5) (NMFS, 2008a).

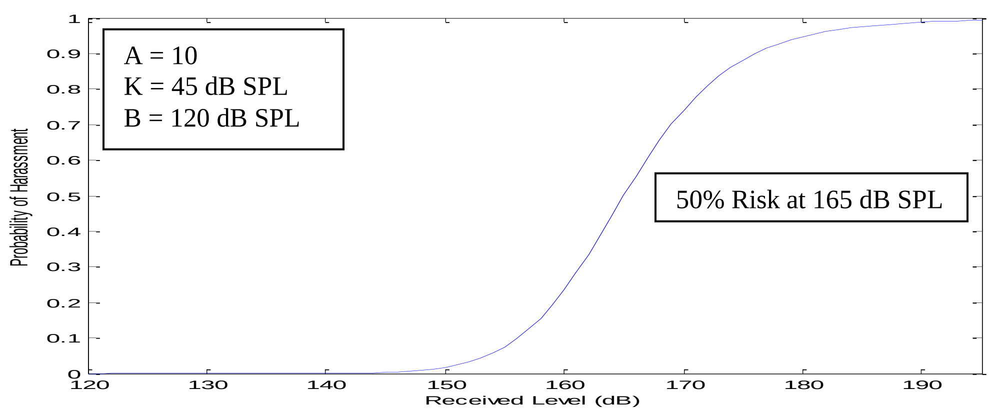


Figure 4-5. Risk Function Curve for Odontocetes

Based on NMFS' direction, the Navy will use a value of A=8 for mysticetes to allow for greater consideration of potential harassment at the lower received levels based on Nowacek et al., 2004 (Figure 4-4) (NMFS, 2008a).

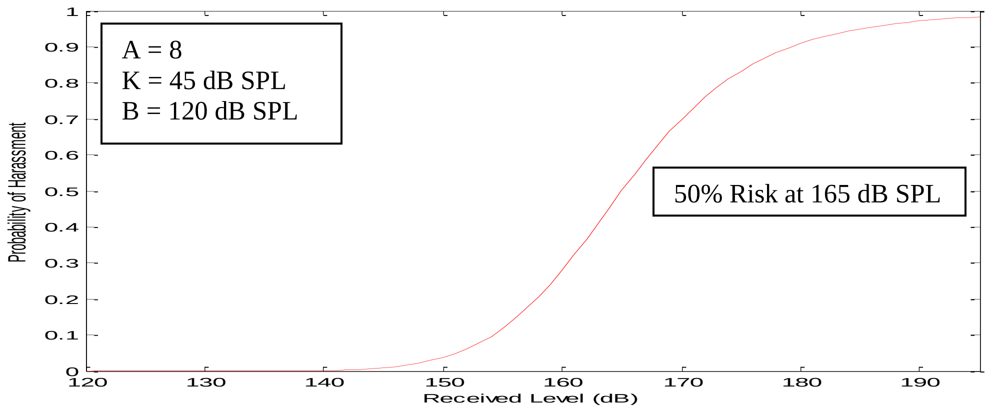


Figure 4-6. Risk Function Curve for Mysticetes (Baleen Whales)

<u>Justification for the Steepness Parameter of A=10 for the Odontocete Curve</u>

The NMFS independent review process described in Section 4.1.2.4.9 of the Hawaii Range Complex EIS/OEIS (DON, 2008q) provided the impetus for the selection of the parameters for the risk function curves. One scientist recommended staying close to the risk continuum concept as used in the SURTASS low-frequency active sonar EIS. This scientist opined that both the basement and slope values; B=120 dB and A=10 respectively, from the SURTASS low-frequency active sonar risk continuum concept are logical solutions in the absence of compelling data to select alternate values supporting the Feller-adapted risk function for mid-frequency active sonar. Another scientist indicated a steepness parameter needed to be selected, but did not recommend a value. Four scientists did not specifically address selection of a slope value. After reviewing the six scientists' recommendations, the two NMFS scientists recommended selection of A=10. Direction was provided by NMFS to use the A=10 curve for odontocetes based on the scientific review of potential risk functions explained in Section 4.1.2.4.9.2 of the Hawaii Range Complex EIS/OEIS (DON, 2008q).

As background, a sensitivity analysis of the A=10 parameter was undertaken and presented in Appendix D of the SURTASS/LFA Final EIS (DON, 2001). The analysis was performed to support the A=10 parameter for mysticete whales responding to a low-frequency sound source, a frequency range to which the mysticete whales are believed to be most sensitive to. The sensitivity analysis results confirmed the increased risk estimate for animals exposed to sound levels below 165 dB. Results from the Low Frequency Sound Scientific Research Program (LFS SRP) phase II research showed that whales (specifically gray whales in their case) did scale their responses with received level as supported by the A=10 parameter (Buck and Tyack, 2000). In the second phase of the LFS SRP research, migrating gray whales showed responses similar to those observed in earlier research (Malme et al., 1983; 1984) when the LF source was moored in the migration corridor (2 km [1.1 NM] from shore). The study extended those results with confirmation that a louder SL elicited a larger scale avoidance response. However, when the source was placed offshore (4 km [2.2 NM] from shore) of the migration corridor, the avoidance response was not evident. This implies that the inshore avoidance model – in which 50 percent of the whales avoid exposure to levels of 141 $\pm$ 3 dB – may not be valid for whales in proximity to an offshore source (DON, 2001). As concluded in the SURTASS LFA Sonar Final OEIS/EIS (DON, 2001), the value of A=10 produces a curve that has a more gradual transition than the curves developed by the analyses of migratory gray whale studies (Malme et al., 1984; Buck and Tyack, 2000; and DON, 2001 [Subchapters 1.43, 4.2.4.3 and Appendix D], and NMFS, 2008a).

Justification for the steepness parameter of A=8 for the Mysticete Curve

The Nowacek et al. (2004) study provides the only available data source for a mysticete species behaviorally responding to a sound source (*i.e.*, alert stimuli) with frequencies in the range of tactical mid-frequency sonar (1 to 10 kHz), including empirical measurements of received levels (RLs). While there are fundamental differences in the stimulus used by Nowacek et al. (2004) and tactical mid-frequency sonar (*e.g.*, source level, waveform, duration, directionality, likely range from source to receiver), they are generally similar in frequency band and the presence of modulation patterns. Thus, while they must be considered with caution in interpreting behavioral responses of mysticetes to mid-frequency sonar, they seemingly cannot be excluded from this consideration given the overwhelming lack of other information. The Nowacek et al. (2004) data indicate that five out the six North Atlantic right whales exposed to an alert stimuli "significantly altered their regular behavior and did so in identical fashion" (*i.e.*, ceasing feeding and swimming to just under the surface). For these five whales, maximum RLs associated with this response ranged from root- mean-square sound (rms) pressure levels of 133 to 148 dB (re: 1 μPa).

When six scientists (one of them being Nowacek) were asked to independently evaluate available data for constructing a dose response curve based on a solution adapted from Feller (1968), the majority of them (4 out of 6; one being Nowacek) indicated that the Nowacek et al. (2004) data were not only appropriate but also necessary to consider in the analysis. While other parameters associated with the solution adapted from Feller (1968) were provided by many of the scientists (i.e., basement parameter [B], increment above basement where there is 50 percent risk [K]), only one scientist provided a suggestion for the risk transition parameter, A.

A single curve may provide the simplest quantitative solution to estimating behavioral harassment. However, the policy decision, by NMFS-OPR, to adjust the risk transition parameter from A=10 to A=8 for mysticetes and create a separate curve was based on the fact the use of this shallower slope better reflected the increased risk of behavioral response at relatively low RLs suggested by the Nowacek et al. (2004) data. In other words, by reducing the risk transition parameter from 10 to 8, the slope of the curve for mysticetes is reduced. This results in an increase the proportion of the population being classified as behaviorally harassed at lower RLs. It also slightly reduces the estimate of behavioral response probability at quite high RLs, though this is expected to have quite little practical result owing to the very limited probability of exposures well above the mid-point of the function. This adjustment allows for a slightly more conservative approach in estimating behavioral harassment at relatively low RLs for mysticetes compared to the odontocete curve and is supported by the only dataset currently available. It should be noted that the current approach (with A=8) still yields an extremely low probability for behavioral responses at RLs between 133 to 148 dB, where the Nowacek data indicated significant responses in a majority of whales studied. (Creating an entire curve based strictly on the Nowacek et al. [2004] data alone for mysticetes was advocated by several of the reviewers and considered inappropriate, by NMFS-OPR, since the sound source used in this study was not identical to tactical mid-frequency active sonar, and there were only five data points available.) The policy adjustment made by NMFS-OPR was also intended to capture some of the additional recommendations and considerations provided by the scientific panel (i.e., the curve should be more data driven and that a greater probability of risk at lower RLs be associated with direct application of the Nowacek et al. [2004] data).

4.4.5.3.8 Basic Application of the Risk Function and Relation to the Current Regulatory Scheme

The risk function is used to estimate the percentage of an exposed population that is likely to exhibit behaviors that would qualify as harassment (as that term is defined by the MMPA applicable to military readiness activities, such as the Navy's testing and training with mid-frequency active sonar) at a given received level of sound. For example, at 165 dB SPL (dB re 1µPa rms), the risk (or probability) of harassment is defined according to this function as 50 percent, and Navy/NMFS applies that by estimating that 50 percent of the individuals exposed at that received level are likely to respond by exhibiting behavior that NMFS would classify as behavioral harassment. The risk function is not applied to individual animals, only to exposed populations.

The data used to produce the risk function were compiled from four species that had been exposed to sound sources in a variety of different circumstances. As a result, the risk function represents a general relationship between acoustic exposures and behavioral responses that is then applied to specific circumstances. That is, the risk function represents a relationship that is deemed to be generally true, based on the limited, best-available science, but may not be true in specific circumstances. In particular, the risk function, as currently derived, treats the received level as the only variable that is relevant to a marine mammal's behavioral response. However, we know that many other variables, such as the marine mammal's gender, age, and prior experience; the activity it is engaged in during an exposure event; its distance from a sound source; the number of sound sources; and whether the sound sources are approaching or moving away from the animal can be critically important in determining whether and how a marine mammal will respond to a sound source (Southall et al., 2007). The data that are currently available do not allow for incorporation of these other variables in the current risk functions; however, the risk function represents the best use of the data that are available.

NMFS and Navy made the decision to apply the mid-frequency active sonar risk function curve to high-frequency active sources due to lack of available and complete information regarding high-frequency active sources. As more specific and applicable data become available for mid- and high-frequency active sources, NMFS can use these data to modify the outputs generated by the risk function to make them more realistic. Ultimately, data may exist to justify the use of additional, alternate, or multi-variate functions. As mentioned above, it is known that the distance from the sound source and whether it is perceived as approaching or moving away can affect the way an animal responds to a sound (Wartzok et al., 2003). In the Hawaii Range Complex EIS/OEIS example, animals exposed to received levels between 120 and 130 dB may be more than 121 km (65 NM) from a sound source; those distances would influence whether those animals might perceive the sound source as a potential threat, and their behavioral responses to that threat. Though there are data showing marine mammal responses to sound sources at that received level, NMFS does not currently have any data that describe the response of marine mammals to sounds at that distance (or to other contextual aspects of the exposure, such as the presence of higher frequency harmonics), much less data that compare responses to similar sound levels at varying distances. However, if data were to become available that suggested animals were less likely to respond (in a manner NMFS would classify as harassment) to certain levels beyond certain distances, or that they were more likely to respond at certain closer distances, the Navy will re-evaluate the risk function to try to incorporate any additional variables into the "take" estimates.

Last, pursuant to the MMPA, an applicant is required to estimate the number of animals that will be "taken" by their activities. This estimate informs the analysis that NMFS must perform to determine whether the activity will have a "negligible impact" on the species or stock. Level B (behavioral) harassment occurs at the level of the individual(s) and does not assume any resulting population-level consequences, though there are known avenues through which behavioral disturbance of individuals can result in population-level effects. Alternately, a negligible impact finding is based on the lack of likely adverse effects to annual rates of recruitment or survival (i.e., population-level effects). An estimate of the number of Level B harassment takes, alone, is not enough information on which to base an impact determination. In addition to considering estimates of the number of marine mammals that might be "taken" through harassment, NMFS must consider other factors, such as the nature of any responses (their intensity, duration, etc.), the context of any responses (critical reproductive time or location, migration, etc.), or any of the other variables mentioned in the first paragraph (if known), as well as the number and nature of estimated Level A takes, the number of estimated mortalities, and effects on habitat. Generally speaking, the Navy and NMFS anticipate more severe effects from takes resulting from exposure to higher received levels (though this is in no way a strictly linear relationship throughout species, individuals, or circumstances) and less severe effects from takes resulting from exposure to lower received levels.

Table 4-6 below is a summation of risk function data for the most powerful mid-frequency active sonar, the AN/SQS-53. It shows the percent of harassments at given decibel levels and the corresponding distances from the noise source within which those harassments would occur. Approximately 89 percent of behavioral harassments happen between 150 and 180 dB at ranges between 60 to 0.8 km (32 to 0.4 NM). For lesser powerful systems, the distance range of exposure would decrease.

Table 4-6. Harassments at Each Received Level for Mid-Frequency Active Sonar

Received Level	Distance at Which Levels Occur Within AFAST Study Area	Percentage of Harassments Occurring at Given Levels
120 <= SPL < 130	185 km – 138 km	0%
130 <= SPL < 140	138 km – 96 km	<1%
140 <= SPL < 150	96 km – 60 km	3%
150 <= SPL < 160	60 km – 27 km	21%
160 <= SPL < 170	27 km – 7 km	43%
170 <= SPL < 180	7 km – 0.8 km	25%
180 <= SPL < 190	830 m – 240 m	7%
190 <= SPL < 195	240 m – 120 m	1%
PTS (215 dB SPL)	10 m	0%

If graphically depicted, percent harassment by received decibel level for the same mid-frequency active sonar as that from Table 4-6 would follow the curve shown in Figure 4-7. As can be seen also in Table 4-6, Figure 4-7 illustrates that the bulk of harassments are centered on the 160 to 170 dB level.

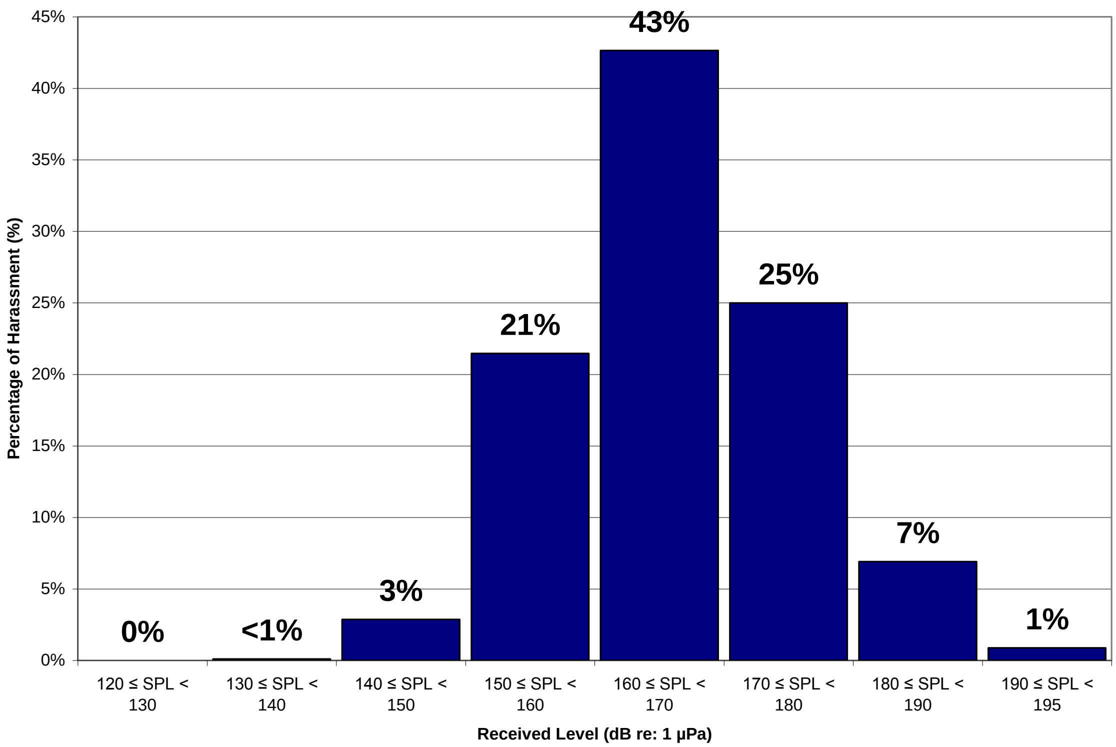


Figure 4-7. Risk Function Predicted Percentage of Behavioral Harassments for Mid-Frequency Active Sonar

4.4.5.3.9 Specific Consideration for Harbor Porpoises

The information currently available regarding these inshore species that inhabit shallow and coastal waters suggests a very low threshold level of response for both captive and wild animals. Threshold levels at which both captive (e.g. Kastelein et al., 2000, 2005, 2006) and wild harbor porpoises (e.g. Johnston, 2002) responded to sound (e.g. acoustic harassment devices (ADHs), acoustic deterrent devices (ADDs), or other non-pulsed sound sources) is very low (e.g. approximately 120 dB SPL), although the biological significance of the disturbance is uncertain. Therefore, Navy will not use the risk function curve as presented but will apply a step function threshold of 120 dB SPL estimate take of harbor porpoises (i.e., assumes that all harbor porpoises exposed to 120 dB or higher mid- or high-frequency active sonar will respond in a way NMFS considers behavioral harassment).

4.4.5.3.10 Critique of the Two Risk Function Curves as Presented in the Final EIS/OEIS for the Hawaii Range Complex

The risk functions used in this Final EIS / OEIS to assess non-injurious temporary behavioral effects to marine mammals were first set forth in the Navy's Final EIS / OEIS for the Hawaii Range Complex [DON, 2008q). The Navy received several comments on the Hawaii Range Complex Final EIS/OEIS critical of the risk function curves specified by NMFS. In reviewing whether the parameters employed were based upon the best available science, the implications in the uncertainty in the values, and biases and limitations in the risk function criteria, such critique asserted that data were incorrectly interpreted by NMFS when calculating parameter values, resulting in a model that underestimates takes. Of primary importance to these commenters was the point that the risk function curves specified by NMFS do not account for a wide range of frequencies from a variety of sources (e.g., motor boats, seismic survey activities, banging on a pipe). In fact, all of the critique concerning "data sets not considered" by NMFS relate to sound sources that are either higher or lower in frequency than mid-frequency active sonar, are contextually different (such as those presented in whale watch vessel disturbances or oil industry activities), or are relatively continuous in nature as compared to intermittent sonar pings. These sounds from data sets not considered have no relation to the frequency or duration of a typical Navy mid-frequency active sonar as described in this Final EIS/OEIS.

As discussed above and in the Final EIS/OEIS, NMFS selected data sets that were relevant to mid-frequency active sonar sources and selected parameters accordingly. In order to satisfy the concern reflected in that a risk function must be inherently precautionary, NMFS could have selected data sets and developed parameters derived from a wide variety of sources across the entire spectrum of sound frequencies in addition to or as substitutes for those that best represent the Navy's mid-frequency active sonar. The net result, however, would have been a risk function that captures a host of behavioral responses beyond those that are biologically significant as contemplated by the definition of Level B harassment under the MMPA applicable to military readiness activities.

Given the results of the modeling and the marine mammal densities in the AFAST Study Area, having a lower basement value would not result in any significant number of additional takes. This is demonstrated in Table 4-6, which shows that less than 1 percent of the predicted number of takes resulted from exposures below 140 dB. Accordingly, while lowering the basement value from 120 dB to something "far lower than 110 dB" would change the risk function curve, it is not likely to result in any appreciable increase in the number of takes. In addition, lowering the basement value below the present 120 dB would involve modeling for impacts occurring below the naturally occurring ambient background noise present in the AFAST area.

Such critique suggests that the criteria used to establish the risk function parameters should reflect the biological basement where any reaction is detectable. The MMPA did not intend to regulate any and all marine mammal behavioral reactions as suggested by the comment. Congress's intent is reflected in the 2003 amendments to the MMPA which re-defined harassment as applied to military readiness activities: "(i) any act that injures or has the significant potential to injure a marine mammal or marine mammal stock in the wild (Level A Harassment); or (ii) any act that disturbs or is likely to disturb a marine mammal or marine mammal stock in the wild by causing disruption of natural behavioral patterns, including, but not limited to, migration, surfacing, nursing, breeding, feeding, or sheltering, to a point where such behavioral patterns are abandoned or significantly altered (Level B Harassment).” Therefore, Congress, by amending the MMPA, specifically did not intend to regulate any and all behavioral reactions as the comment suggests. NMFS, as the regulator, specified the data sets and parameters for use in the risk function analysis. NMFS, as a cooperating agency and in its role as the MMPA regulator, reviewed all available applicable data and determined there were specific data from three data sets that should be used to develop the criteria. NMFS then applied the risk function to predict exposures that resulted in exposures that NMFS may classify as harassment. As discussed above, NMFS developed two risk curves based on the Feller adaptive risk function, one for odontocetes and pinnipeds and one for mysticetes, with input parameters of B=120 dB, K=45, 99 percent point = 195 dB, 50 percent point = 165 dB. Only data sets with continuous, low frequency sound sources (drilling, aircraft or machinery) provided a K value that would have approached a 100 percent probability of a response but these are not applicable to mid-frequency active sonar.

Various comments recommending that the B parameter and the data used should be revised given that, “. . . 120 dB re 1µPa has broadly been found as the value at which 50 percent of individuals respond to noise . . .” and that “. . . 50 percent of migrating whales changed course to remain outside the 120 dB re 1µPa contour (citing to Malme et al. 1983, 1984);” and that “. . . mysticetes exposed to a variety of sounds associated with the oil industry, typically 50 percent exhibited responses at 120 dB re 1µPa” are factually inaccurate. All of these comments provided a single citation to Malme et al. (1983, 1984) for the repeated assertion that 50 percent of marine mammals will react to 120 db re 1µPa. Malme et al. (1983, 1984) in fact indicated that for migrating whales, a 50-percent probability of response occurred at 170 dB for a continuous, low frequency sound source that is very different from mid-frequency active sonar.

Regarding critique that the model underestimates takes because of uncertainty arising from “inter-specific variation” or from “broad confidence intervals,” the risk function methodology assumes variations in responses within the species and was chosen specifically to account for uncertainties and the limitations in available data. NMFS considered all available data sets and, as discussed above, made a determination as to the best data currently available. While the data sets have limitations, they constitute the best available science.

Critique that the model has limitations in that it does not account for social factors, and is likely to underestimate takes, reflects a concern that if one animal is “taken” and leaves an area then the whole pod would likely follow. As explained in Appendix H to the Final EIS/OEIS, the model does not operate on the basis of an individual animal but quantifies the exposures NMFS may classify as takes based on the summation of fractional marine mammal densities. Because the model does not consider the many mitigation measures that the Navy utilizes when it is using mid-frequency active sonar, to include mid-frequency active sonar power down and power off requirements should mammals be spotted within certain distances of the ship, if anything, it overestimates the amount of takes.

Lastly, regarding critique that there are additional datasets, including datasets not considered by NMFS and the Navy, that should have been considered and not having done so resulted in the model underestimating takes, the various data sources suggested by the commenters involve contexts that are neither applicable to the proposed actions nor the sound exposures resulting from those actions. For instance, Lusseau et al. (2006) involved disturbance to a small pod of dolphins exposed to 8,500 whale-watching opportunities annually. This is nothing like the type or frequency of action that is proposed by the Navy for the AFAST area. In a similar manner, the example from noise used in drive fisheries is not applicable to Navy training. Navy training involving the use of active sonar typically occurs in situations where the ships are located miles apart, the sound is intermittent, and the training does not involve surrounding the marine mammals at close proximity. Furthermore, suggestions that effects from acoustic harassment devices and acoustic deterrent devices, which are relatively continuous, high frequency sound sources (unlike mid-frequency active sonar) and are specifically designed to exclude marine mammals from habitat, are also fundamentally different from the use of mid-frequency active sonar. Finally, reactions to airguns used in seismic research or other activities associated with the oil industry are also not applicable to mid-frequency active sonar, since the sound or noise source, its frequency, source level, and manner of use is fundamentally different.

4.4.5.3.11 Navy Post Acoustic Modeling Analysis

The quantification of the acoustic modeling results includes additional analysis to increase the accuracy of the number of marine mammals affected. Table 4-7 provides a summary of the modeling protocols used in this analysis. Post modeling analysis includes reducing acoustic footprints where they encounter land masses, accounting for acoustic footprints for sonar sources that overlap to accurately sum the total area when multiple ships are operating together, and to better account for the maximum number of individuals of a species that could potentially be exposed to sonar within the course of one day or a discreet continuous sonar event.

Table 4-7. Navy Protocols Providing for Accurate Modeling Quantification of Marine Mammal Exposures

Historical Data	**Sonar Positional Reporting System (SPORTS)**	**Annual active sonar usage data is obtained from the SPORTS database to support the determination of mid-frequency active sonar hours and the geographic location of those hours for modeling purposes.**
Acoustic Parameters	AN/SQS-53 and AN/SQS-56	The AN/SQS-53 and the AN/SQS-56 active sonar sources were modeled separately to account for the differences in source level, frequency, and exposure effects.
	Submarine Sonar	Submarine active sonar use is included in effects analysis calculations.
Post Modeling Analysis	Land Shadow	Land shadow was determined to not affect the modeling results and was not included because of the distance from shore of the majority of AFAST active sonar activities.
	Multiple Ships	Potential for double counting is low due to the wide area over which sonar activities could occur in the AFAST Study Area.
	Multiple Exposures	Accurate accounting for AFAST training events within the course of one day or a discreet continuous sonar event: • Unit Level Training – 1 to 6 hours • C2X – 24 hours • JTFEX – 24 hours

4.4.6 Criteria and Thresholds for Small Explosives

Criteria and thresholds for estimating the exposures from a single explosive activity on marine mammals were established for the Seawolf Submarine Shock Test Final Environmental Impact Statement (FEIS) ("Seawolf") and subsequently used in the USS Winston S. Churchill (DDG-81) Ship Shock FEIS ("Churchill") (DON, 1998 and 2001b). The only explosive source analyzed in the AFAST EIS/OEIS is the explosive source sonobuoy (AN/SSQ-110A). Due to the physical and time spacing of sonobuoy detonations, these detonations are treated as individual explosions with non-overlapping sound fields for the purpose of this analysis. NMFS adopted these criteria and thresholds in its final rule on unintentional taking of marine animals occurring incidental to the shock testing (NOAA, 1998). In addition, this section reflects a revised acoustic criterion for small underwater explosions (i.e., 23 pounds per square inch [psi] instead of previous acoustic criteria of 12 psi for peak pressure over all exposures), which is based on an incidental harassment authorization (IHA) issued to the U.S. Air Force (NOAA, 2006c).

4.4.6.1 Criteria and Thresholds for Injurious Physiological Effects

The approach to risk assessment for impulsive sound in the water was derived from the Seawolf/Churchill approach. Churchill used three criteria: eardrum rupture (i.e., tympanic-membrane [TM] rupture), onset of extensive lung injury, and onset of slight lung injury. The threshold for TM rupture corresponds to a 50 percent rate of rupture (i.e., 50 percent of animals exposed to the level are expected to suffer TM); this is stated in terms of an EL value of 1.17 inch pounds per square inch (in-lb/in^2) (about 205 dB re 1 µPa^2-s). This recognizes that TM rupture is not necessarily a serious or life-threatening injury, but it is a useful index of possible injury that is well correlated with measures of permanent hearing impairment (e.g., Ketten [1998] indicates a 30 percent incidence of PTS at the same threshold).

The criteria for mortality is the onset of extensive lung injury. For small mammals, the threshold is given in terms of the Goertner modified positive impulse, indexed to 30.5 pounds per square inch-millisecond (psi-ms). For medium and large mammals, the threshold is 73.9 and 111.7 psi-ms, respectively. In this assessment, all cetaceans were analyzed using the threshold for small mammals for extensive lung injury. The results of the analysis, therefore, are conservative.

The threshold for onset of slight lung injury was calculated for a calf dolphin (12.2 kg [27 lbs]) and an adult dolphin (174 kg [384 lbs]); it is given in terms of the Goertner modified positive impulse, indexed to 13 psi-ms and 32 psi-ms respectively. In this assessment, all cetaceans were analyzed using the threshold for a calf dolphin for onset slight lung injury. The results of the analysis, therefore, are conservative.

4.4.6.2 Criteria and Thresholds for Noninjurious Physiological Effects

The Churchill criterion for non-injurious harassment is TTS, which is a slight, recoverable loss of hearing sensitivity (DON, 2001b). In this case, there are two thresholds, one for energy and one for peak pressure.

4.4.6.3 TTS Energy Threshold

The TTS energy threshold is a 182 dB re 1 μPa^2-s maximum energy flux density level in any 1/3-octave band at frequencies above 0.1 kHz for toothed whales and in any 1/3-octave band above 0.010 kHz for baleen whales. For large explosives, the latter limits at 0.01 and 0.1 kHz make a difference in the range estimates. NMFS has defined large explosives in prior rulemaking as greater than 907 kg (2,000 lbs) Net Explosive Weight (NEW) (NMFS, 2006k). The Navy has defined small explosives as less than 680 kg (1,500 lbs) NEW per directive. For small explosives, the spectrum of the shot arrival is broad and there is essentially no difference in effects ranges for the two classes of animals.

4.4.6.4 TTS Peak Pressure Threshold

The TTS peak pressure threshold applies to all cetacean species and is stated in terms of peak pressure at 23 psi, which is based on an IHA issued to the Air Force for a similar action (NOAA, 2006d). This threshold is derived from the Churchill threshold. However, peak pressure and energy scale at different rates with charge weight, so that ranges based on the peak-pressure threshold are much greater than those for the energy metric when charge weights are small—even when source and animal are away from the surface. In order to more accurately estimate TTS for smaller shots while preserving the safety feature provided by the peak pressure threshold, the peak pressure threshold was appropriately scaled for small detonations. This scaling is based on the similitude formulas (e.g., Urick, 1983) used in virtually all compliance documents for short ranges. Further, the peak-pressure threshold for marine mammal TTS for explosives offers a safety margin for a source or an animal near the ocean surface.

4.4.6.5 Criteria and Thresholds for Behavioral Effects

Behavioral modification (sub-TTS) is only applied to successive detonations. For single detonations, behavioral disturbance is likely to be limited to a short-lived startle reaction; therefore, use of the TTS criterion is considered sufficient protection.

4.4.7 Summary of Criteria and Thresholds

Table 4-8 summarizes the effects, criteria, and thresholds used in the assessment to determine potential physiological effects from active sonar.

Tables 4-9 and 4-10 summarize the SPL risk-function parameters for behavioral response to active sonar.

Table 4-11 summarizes the effects, criteria, and thresholds used in the assessment for small explosives (explosive source sonobuoy [AN/SSQ-110A]).

Table 4-8. Effects, Criteria, and Thresholds for Active Sonar

Effect	Criteria	Threshold (dB 1 μPa^2-s)	MMPA Effect
Physiological	PTS (cetaceans)	215	Level A harassment
Physiological	PTS (harbor seals)	203	Level A harassment
Physiological	TTS	195	Level B harassment
Physiological	TTS (harbor seals)	183	Level B harassment

dB 1 μPa^2-s = decibel referenced to 1 micropascal squared second; PTS = Permanent Threshold Shift; TTS = Temporary Threshold Shift

Table 4-9. SPL Risk-Function Parameters for Behavioral Response to Active Sonar

Animals	Risk-Function Mean (SPL)	Risk Transition Parameter	Basement Receive Level
Odontocetes (except harbor porpoises) and Pinnipeds	165 dB	10	120 dB
Mysticetes	165 dB	8	120 dB

dB = decibel

Table 4-10. Behavioral Response to Active Sonar (Harbor Porpoise)

Animals	Effect	Receive Level
Harbor Porpoise	Behavioral	Greater than 120 dB SPL re 1 μPa

dB = decibel; SPL re 1 μPa = sound pressure level referenced to 1 micropascal

Table 4-11. Effects, Criteria, and Thresholds for Small Explosives

Effect	Criteria	Metric	Threshold	MMPA Effect
Physiological	Onset extensive lung injury	Goertner modified positive impulse	30.5 psi-ms	Mortality
Physiological	50 percent TM rupture	Energy flux density	1.17 in-lb/in^2 (about 205 dB re 1 μPa^2-s)	Level A Harassment
Physiological	Onset slight lung injury	Goertner modified positive impulse	indexed to 13 psi-ms	Level A Harassment
Physiological	TTS for baleen whales	Greatest energy flux density level in any 1/3-octave band above 10 Hz - for total energy over all exposures	182 dB re 1 μPa^2-s	Level B Harassment
Physiological	TTS for toothed whales and sea turtles	Greatest energy flux density level in any 1/3-octave band above 100 Hz - for total energy over all exposures	182 dB re 1 μPa^2-s	Level B Harassment
Physiological	TTS	Peak pressure over all exposures	23 psi	Level B Harassment

dB 1 μPa^2-s = decibel referenced to 1 micropascal squared second; Hz = hertz; psi-ms = pounds per square inch-millisecond; TM = tympanic membrane; TTS = temporary threshold shift

4.4.8 Acoustic Effects Analysis

Potential acoustic sources to be modeled for the AFAST EIS/OEIS were examined with regard to their source characteristics in order to determine whether they should be included in the marine mammal acoustic impact analysis. Systems with an operating frequency greater than 200 kHz were not analyzed, as these signals attenuate rapidly during propagation (30 dB/km or more signal spreading losses), resulting in very short propagation distances. In addition, such frequencies are outside the known hearing range of most marine mammals. Although there are no direct data on auditory thresholds for any mysticete species, anatomical evidence strongly suggests that their inner ears are well adapted for low-frequency hearing. (Richardson et al., 1995; Ketten, 1998) Filter-bank models of the humpback whale's ear have been developed from anatomical features and optimization techniques (Houser et al., 2001). The results suggest that humpbacks are sensitive to frequencies between 40 Hz and 16 kHz, but best sensitivity is likely to occur between 100 Hz and 8 kHz.

Most available information on cetacean hearing pertains to odontocetes, which commonly have good functional hearing between 200 Hz and 100 kHz, although individual species may have functional ultrasonic hearing to nearly 200 kHz (Richardson et al., 1995). Some of the species with ultrasonic hearing are *Kogia* to 150 kHz (Ridgway and Carder, 2001), striped dolphins 160 kHz (Kastelein et al., 2003), and harbor porpoise, 180 kHz (Kastelein et al., 2002). In all cases these frequencies represent the upper limit of capability with their best frequency range considerably below that. In pinnipeds, the animals with the highest-frequency hearing are phocid seals; their functional high-frequency limit is around 60 kHz (Terhune, 1988; Richardson, 1995). To summarize, marine mammals as a group have functional hearing ranges of 10 Hz to 200 kHz, with their best sensitivities well below that level. Because sources operating at 200 kHz or higher attenuate rapidly and are at or outside the upper frequency limit of even the ultrasonic species of marine mammals, further consideration and modeling of these higher frequency acoustic sources are not warranted.

4.4.8.1 Active Sonar

The analysis occurred in five broad steps. An overview of each step is provided below.

1. Each source emission is modeled according to the particular operating mode of the sonar. See Table 4-5 for a description of sources modeled. The "effective" energy source and sound pressure level is computed by integrating over the bandwidth of the source, scaling by the pulse length, and adjusting for gains due to source directivity. The location of the source at the time of each emission must also be specified.
2. For the relevant environmental acoustic parameters, transmission loss (TL) estimates are computed, sampling the water column over the appropriate depth and range intervals. TL data are sampled at the typical depth(s) of the source and at the nominal frequency of the source. If the source is relatively broadband, an average over several frequency samples may be appropriate.
3. The accumulated energy and maximum received sound pressure level within the waters in which the sonar is operating is sampled over a volumetric grid. At each grid point, the received sound from each source emission is modeled as the effective energy source and sound pressure level reduced by the appropriate propagation loss from the location of the source at the time of the emission to that grid point.
4. For energy criteria, the zone of influence (ZOI) for a given threshold (that is, the volume for which the accumulated energy level exceeds the threshold) is estimated by summing

the incremental volumes represented by each grid point for which the accumulated energy flux density exceeds that threshold. For the sound pressure level, the maximum received sound pressure level is compared to the appropriate risk function for the marine mammal group and source frequency of interest. The percentage of animals likely to respond corresponding to the maximum received level is found, and the volume of the grid point is multiplied by that percentage to find the adjusted volume. Those adjusted volumes are summed across all grid points to find the overall ZOI.

5. The number of animals exposed to any given acoustic threshold is estimated by multiplying the animal densities by the effect area (derived from the effect volume). The animal density used in the calculation of exposures is the average density across the specific area of interest. It assumes the animals are evenly distributed across the area of interest.

Acoustic propagation and mammal population data are analyzed by season. The analysis estimated the sound exposure for marine mammals produced by each active source type independently. Results from each acoustic source were added on a per-training exercise basis and then activities were summed to annual totals.

The relevant measure of potential physiological effects to marine mammals due to sonar training is the modeled accumulated (summed over all source emissions) energy flux density level received by the animal over the duration of the activity. To calculate the estimated exposures using EL, the seasonal exposure zones generated during the acoustic modeling are multiplied by the average density of each species per season by OPAREA. Behavioral effects below the 195 dB EL threshold were modeled using the risk function.

4.4.8.2 Small Explosives (Explosive Source Sonobuoy [AN/SSQ-110A])

The impact of explosive sources on marine wildlife is measured by three different metrics, each with its own threshold(s). The energy metric, peak one-third octave, is treated in similar fashion as the energy metric used for the active sonars, including the summation of energy if there are multiple source emissions. The other two, peak pressure and positive impulse, are not accumulated; rather, the maximum levels are stored.

4.4.8.2.1 Peak One-Third Octave Energy Metric

The computation of impact volumes for the energy metric follows closely the approach taken to model the energy metric for the active sonars. The only significant difference is that energy flux density is sampled at several frequencies in one-third-octave bands and only the peak one-third-octave level is accumulated.

4.4.8.2.2 Peak Pressure Metric

The peak pressure metric is a simple, straightforward calculation. At each range/animal depth combination, transmission ratio modified by the source level in a one-octave band and beam pattern is averaged across frequency on an eigenray-by-eigenray basis. This averaged transmission ratio (normalized by the broadband source level) is then compared across all eigenrays with the maximum designated as the peak arrival. Peak pressure at that range/animal depth combination is then simply the product of:

- The square root of the averaged transmission ratio of the peak arrival,
- The peak pressure at a range of 1 m, and
- The similitude correction.

If the peak pressure for a given grid point is greater than the specified threshold, then the incremental volume for the grid point is added to the impact volume for that depth layer.

4.4.8.2.3 Modified Positive Impulse Metric

The modeling of positive impulse follows the work of Goertner. The modified positive impulse threshold is unique among the various injury and harassment metrics in that it is a function of depth and the animal weight. To be conservative, the Navy will assume the animal weight is that of a calf dolphin, with an average mass of 12.2 kg (27 lb).

Although the thresholds are a function of depth and animal weight, sometimes they are summarized as their value at the sea surface for a typical calf dolphin (with an average mass of 12.2 kg [27 lb]). For the onset of slight lung injury, the threshold at the surface is approximately 13 psi ms; for the onset of extensive lung hemorrhaging (1 percent mortality), the threshold at the surface is approximately 31 psi-ms.

4.4.9 Acoustic Effects Results for Marine Mammals

4.4.9.1 Marine Mammal Density Assumptions

The updated density estimates used in the acoustic effects analysis are derived from the *Navy OPAREA Density Estimates (NODE) for the Northeast OPAREAs* report (DON, 2007c*)*, the *NODE for the Southeast OPAREAs* report (DON, 2007a), and the *NODE for the GOMEX OPAREA* report (DON, 2007b). Refer to Section 3.2.2 for a more detailed discussion of the Navy OPAREA density estimates. In this analysis, marine mammal densities were averaged across specific active sonar activity areas and, therefore, are evenly distributed without consideration for animal grouping or patchiness.

Exposure numbers for these species occurring within the AFAST Study Area could not be calculated due to the lack of appropriate data needed to generate density estimates. However, potential effects to these species were qualitatively analyzed. These species include the following:

- Blue whale
- Hooded seal
- Harp seal

Exposure numbers for the manatees occurring in the Southeast could not be calculated due to the lack of acoustic exposure criteria and lack of available density information. In addition, three species have no density estimate since their occurrence is considered extralimital throughout the AFAST Study Area. These species have a functional density of zero; therefore, no potential effects are predicted. These species include the following:

- Beluga whale
- Ringed seal

For some species, data exists to generate density estimates in a portion of the AFAST Study Area, but not for the entire Study Area. Even though no exposures could be calculated in these areas, exposures could occur to these species; however, limited sighting data may indicate that the likelihood of exposure is low. Therefore, the exposure calculations are provided only for those areas in which density estimates are available. These species include the following:

- Sei whale (northeast)
- Atlantic white-sided dolphin (northeast)
- Spinner dolphin (Gulf of Mexico)
- Pygmy killer whale (Gulf of Mexico)
- Killer whale (Gulf of Mexico)
- False killer whale (Gulf of Mexico)
- Melon-headed whale (Gulf of Mexico)
- Fraser's dolphin (Gulf of Mexico)
- Harbor porpoise (northeast)

Specifically, in the case of the sei whale, sei whale density data does not extend to the shelf break. Since sei whales have a worldwide distribution, known estimated densities along the shelf were extended seaward for the purposes of estimating exposures.

4.4.9.2 Model Assumptions

When analyzing the results of the acoustic effects modeling to provide an estimate of effects, it is important to understand that there are limitations to the ecological data and to the acoustic model, which in turn, leads to an overestimation (i.e., conservative estimate) of the total exposures to marine mammals. Specifically, the modeling results are conservative for the following reasons:

- Acoustic footprints for sonar sources near land are not reduced to account for the land mass where marine mammals would not occur.
- Acoustic analysis assumes ships travel in a straight line, constantly encountering new animals. In reality, ships usually search an area in a pattern, exposing fewer animals during a single day.

- The model does not consider any change of behavior (including avoidance, bow-riding or surfacing) of marine mammals in proximity of an intense sound source.
- Acoustic footprints for sonar sources are added independently and, therefore, do not account for overlap they would have with other sonar systems used during the same active sonar activity. As a consequence, the calculated acoustic footprint is larger than the actual acoustic footprint.
- Acoustic exposures do not reflect implementation of mitigation measures, such as reducing sonar source levels when marine mammals are present.
- In this analysis, the acoustic footprint is assumed to extend from the water surface to the ocean bottom. In reality, the acoustic footprint radiates from the source like a bubble, and a marine animal may be outside this region.

4.4.9.3 Acoustic Modeling Results

Annual exposure estimates for the No Action Alternative, Alternative 1, Alternative 2, and Alternative 3 are presented in Tables 4-12 through 4-27. These modeling estimates were both active sonar and explosive source sonobuoys (AN/SSQ-110). Exposures numbers were rounded to “1” if the result was equal to or greater than 0.5. Even though an exposure number may have rounded to “0” in an individual analysis area, when summed with all other results for other analysis areas within the AFAST Study Area, an exposure of “1” is possible.

For the species listed in Section 4.4.9.1 (i.e., Atlantic white-sided dolphin, spinner dolphin, pygmy killer whale, killer whale, false killer whale, melon-headed whale, Fraser’s dolphins, and harbor porpoise), gray highlighting will be used to identify lack of modeling results.

Table 4-12. Estimated Annual Marine Mammal Exposures From ULT, RDT&E, and Maintenance Active Sonar Activities Under the No Action Alternative

Species	Atlantic Ocean, Offshore of the Southeastern United States												Northeast				Gulf of Mexico			
	VACAPES OPAREA				CHPT OPAREA				JAX/CHASN OPAREA				Northeast OPAREA				GOMEX			
	Mortality	PTS	TTS	Risk-Function	Mortality	PTS	TTS	Risk-Function	Mortality	PTS	TTS	Risk-Function	Mortality	PTS	TTS	Risk-Function	Mortality	PTS	TTS	Risk-Function
Atlantic spotted dolphin	0	7	838	79217	0	2	289	31224	0	6	1155	153366	0	0	4	15016	0	2	12	7154
Atlantic white-sided dolphin													0	0	1	20455				
Bottlenose dolphin	0	2	253	26055	0	3	323	42513	0	17	2207	308450	0	0	2	15970	0	1	16	8077
Clymene dolphin	0	0	35	3661	0	0	37	4702	0	1	120	16409					0	0	7	751
Common dolphin	0	3	597	39772	0	0	1	84	0	0	0	0	0	1	10	47562				
False killer whale																	0	0	0	45
Fraser's dolphin																	0	0	0	31
Killer whale																	0	0	0	6
Kogia spp.	0	0	3	348	0	0	4	447	0	0	11	1559	0	0	0	419	0	0	0	11
Melon-headed whale																	0	0	1	149
Pantropical spotted dolphin	0	1	74	7664	0	1	78	9841	0	2	252	34345	0	0	1	9167	0	0	11	2330
Pilot whales* **	0	1	100	10598	0	1	55	7559	0	3	322	45430	0	0	12	22442				
Pygmy killer whale																	0	0	0	21
Risso's dolphin	0	1	60	5936	0	0	45	5632	0	2	257	35503	0	0	2	18560	0	0	1	91
Rough-toothed dolphin	0	0	2	165	0	0	2	212	0	0	5	741					0	0	0	165
Short-finned pilot whale******																	0	0	1	103
Sperm whale**	0	0*	23	2478	0	0	1	179	0	0*	6	840	0	0	1	4369	0	0	0*	22
Spinner dolphin																	0	0	0	874
Striped dolphin	0	6	543	61503	0	0	0	32	0	0	0	0	0	2	10	93371	0	0	0	136
White beaked dolphin													0	0	1	3419				
Beaked whale	0	0	5	638	0	0	2	258	0	0	7	996	0	0	0	1771	0	0	0	5
Harbor porpoise													0	0	0	151058				
Bryde's whale																	0	0	0	2
Fin whale**	0	0	1	58	0	0	0	0	0	0	0	0	0	0	0*	796				
Humpback whale**	0	0	3	342	0	0	3	429	0	0	8	1476	0	0	0*	696				
Minke whale	0	0	0	18	0	0	0	23	0	0*	0	80	0	0	0	226				
North Atlantic right whale**	0	0	0*	42	0	0	0*	23	0	0	2	274	0	0	0*	222				
Sei whale**													0	0	0*	1026				
Gray Seal													0	0	31	7774				
Harbor Seal													0	0	29	12526				

* Indicates an exposure greater than or equal to 0.05, therefore, is considered a "may affect" for ESA-listed species.
**Denotes species listed in accordance with the Endangered Species Act.
***Pilot whales include both short- and long-finned pilot whales along the East Coast
****Reflects short-finned pilot whales in the Gulf of Mexico.

This page is intentionally blank.

Table 4-13. Estimated Annual Marine Mammal Exposures From Coordinated ULT Active Sonar Activities Under the No Action Alternative

Species	Atlantic Ocean, Offshore of the Southeastern United States												Northeast				Gulf of Mexico			
	VACAPES OPAREA				CHPT OPAREA				JAX/CHASN OPAREA				Northeast OPAREA				GOMEX			
	Mortality	PTS	TTS	Risk-Function	Mortality	PTS	TTS	Risk-Function	Mortality	PTS	TTS	Risk-Function	Mortality	PTS	TTS	Risk-Function	Mortality	PTS	TTS	Risk-Function
Atlantic spotted dolphin	0	1	151	6199	0	0	52	2164	0	3	800	39516	0	0	0	125	0	0	0	1908
Atlantic white-sided dolphin													0	0	0	185				
Bottlenose dolphin	0	0	45	2013	0	0	58	3429	0	10	1524	93212	0	0	0	143	0	0	2	3424
Clymene dolphin	0	0	6	247	0	0	7	362	0	1	84	5264					0	0	1	119
Common dolphin	0	0	108	3027	0	0	0	6	0	0	0	0	0	0	0	427	0	0	0	0
False killer whale																	0	0	0	7
Fraser's dolphin																	0	0	0	5
Killer whale																	0	0	0	1
Kogia spp.	0	0	1	23	0	0	1	34	0	0	8	500	0	0	0	4	0	0	0	1
Melon-headed whale																	0	0	0	24
Pantropical spotted dolphin	0	0	13	517	0	0	14	757	0	1	175	11019	0	0	0	83	0	0	2	153
Pilot whales* **	0	0	18	832	0	0	10	618	0	2	224	15772	0	0	0	163				
Pygmy killer whale																	0	0	0	3
Risso's dolphin	0	0	11	465	0	0	8	441	0	1	179	12171	0	0	0	165	0	0	0	11
Rough-toothed dolphin	0	0	0	11	0	0	0	16	0	0	4	238					0	0	0	120
Short-finned pilot whale** **																	0	0	0	16
Sperm whale **	0	0	4	195	0	0	0*	14	0	0	4	284	0	0	0	35	0	0	0	2
Spinner dolphin																	0	0	0	55
Striped dolphin	0	1	98	4854	0	0	0	3	0	0	0	0	0	0	0	842	0	0	0	7
White beaked dolphin													0	0	0	30				
Beaked whale	0	0	1	50	0	0	0	21	0	0	5	341	0	0	0	16	0	0	0	0
Harbor porpoise													0	0	0	1312				
Bryde's whale																	0	0	0	0
Fin whale **	0	0	0*	5	0	0	0	0	0	0	0	0	0	0	0	6				
Humpback whale **	0	0	0*	24	0	0	0*	35	0	0	6	486	0	0	0	6				
Minke whale	0	0	0	1	0	0	0	2	0	0	0	27	0	0	0	2				
North Atlantic right whale **	0	0	0*	2	0	0	0	2	0	0	1	72	0	0	0	1				
Sei whale **													0	0	0	9				
Gray Seal													0	0	0	54				
Harbor Seal													0	0	0	105				

* Indicates an exposure greater than or equal to 0.05, therefore, is considered a "may affect" for ESA-listed species.
**Denotes species listed in accordance with the Endangered Species Act.
***Pilot whales include both short- and long-finned pilot whales along the East Coast
****Reflects short-finned pilot whales in the Gulf of Mexico.

This page is intentionally blank.

Table 4-14. Estimated Annual Marine Mammal Exposures From Strike Group Active Sonar Exercises Under the No Action Alternative

Species	Atlantic Ocean, Offshore of the Southeastern United States												Northeast				Gulf of Mexico			
	VACAPES OPAREA				CHPT OPAREA				JAX/CHASN OPAREA				Northeast OPAREA				GOMEX			
	Mortality	PTS	TTS	Risk-Function	Mortality	PTS	TTS	Risk-Function	Mortality	PTS	TTS	Risk-Function	Mortality	PTS	TTS	Risk-Function	Mortality	PTS	TTS	Risk-Function
Atlantic spotted dolphin	0	2	299	12431	0	1	209	8499	0	1	221	9826	0	0	0	0	0	1	112	5520
Atlantic white-sided dolphin													0	0	0	0				
Bottlenose dolphin	0	1	107	4589	0	3	357	20397	0	7	992	59924	0	0	0	0	0	1	207	12513
Clymene dolphin	0	0	10	390	0	0	43	2337	0	1	73	4391					0	1	106	7275
Common dolphin	0	1	145	4700	0	0	1	21	0	0	0	0	0	0	0	0				
False killer whale																	0	0	6	435
Fraser's dolphin																	0	0	4	304
Killer whale																	0	0	1	56
Kogia spp.	0	0	1	37	0	0	4	222	0	0	7	417	0	0	0	0	0	0	5	319
Melon-headed whale																	0	0	21	1447
Pantropical spotted dolphin	0	0	20	817	0	1	90	4893	0	1	152	9190	0	0	0	0	0	5	682	46962
Pilot whales* **	0	0	41	1790	0	1	69	4072	0	2	251	15880	0	0	0	0				
Pygmy killer whale																	0	0	3	208
Risso's dolphin	0	0	21	875	0	0	47	2566	0	1	149	9495	0	0	0	0	0	0	20	1363
Rough-toothed dolphin	0	0	0	18	0	0	2	106	0	0	3	198					0	0	10	689
Short-finned pilot whale** **																	0	0	15	1001
Sperm whale **	0	0*	9	413	0	0	2	123	0	0*	7	393	0	0	0	0	0	0	5	345
Spinner dolphin																	0	2	289	19695
Striped dolphin	0	1	198	9053	0	0	0	26	0	0	0	0	0	0	0	0	0	0	58	3990
White beaked dolphin													0	0	0	0				
Beaked whale	0	0	2	83	0	0	3	144	0	0	7	394	0	0	0	0	0	0	2	157
Harbor porpoise													0	0	0	0				
Bryde's whale																	0	0	0	23
Fin whale **	0	0	0*	5	0	0	0	0	0	0	0	0	0	0	0	0				
Humpback whale **	0	0	1	37	0	0	3	222	0	0	5	409	0	0	0	0				
Minke whale	0	0	0	2	0	0	0	12	0	0	0	22	0	0	0	0				
North Atlantic right whale **	0	0	0*	1	0	0	0*	5	0	0	0*	16	0	0	0	0				
Sei whale **													0	0	0	0				
Gray Seal													0	0	0	0				
Harbor Seal													0	0	0	0				

* Indicates an exposure greater than or equal to 0.05, therefore, is considered a "may affect" for ESA-listed species.
**Denotes species listed in accordance with the Endangered Species Act.
***Pilot whales include both short- and long-finned pilot whales along the East Coast
****Reflects short-finned pilot whales in the Gulf of Mexico.

This page is intentionally blank.

Table 4-15. Estimated Annual Marine Mammal Exposures from ULT, RDT&E, Maintenance, Coordinated ULT, and Strike Group Active Sonar Activities Under the No Action Alternative

Species	Atlantic Ocean, Offshore of the Southeastern United States												Northeast				Gulf of Mexico			
	VACAPES OPAREA				CHPT OPAREA				JAX/CHASN OPAREA				Northeast OPAREA				GOMEX			
	Mortality	PTS	TTS	Risk-Function	Mortality	PTS	TTS	Risk-Function	Mortality	PTS	TTS	Risk-Function	Mortality	PTS	TTS	Risk-Function	Mortality	PTS	TTS	Risk-Function
Atlantic spotted dolphin	0	10	1287	97900	0	3	551	41887	0	11	2176	202708	0	0	4	15141	0	3	124	14583
Atlantic white-sided dolphin													0	0	1	20639				
Bottlenose dolphin	0	3	405	32657	0	7	738	66340	0	35	4722	461586	0	0	2	16113	0	2	225	24014
Clymene dolphin	0	0	51	4299	0	1	87	7401	0	2	277	26064					0	1	114	8145
Common dolphin	0	4	850	47499	0	0	1	111	0	0	0	0	0	1	10	47989				
False killer whale																	0	0	7	487
Fraser's dolphin																	0	0	5	341
Killer whale																	0	0	1	62
Kogia spp.	0	0	5	408	0	0	8	703	0	0	26	2476	0	0	0	423	0	0	5	330
Melon-headed whale																	0	0	23	1620
Pantropical spotted dolphin	0	1	108	8998	0	2	183	15491	0	5	580	54555	0	0	1	9250	0	5	695	49445
Pilot whales* **	0	1	159	13220	0	1	134	12249	0	7	796	77082	0	0	12	22604				
Pygmy killer whale																	0	0	3	233
Risso's dolphin	0	1	92	7276	0	1	100	8639	0	5	585	57169	0	0	2	18726	0	0	21	1465
Rough-toothed dolphin	0	0	2	194	0	0	4	334	0	0	13	1177					0	0	10	974
Short-finned pilot whale****																	0	0	16	1121
Sperm whale**	0	0*	36	3087	0	0	4	317	0	0*	17	1517	0	0	1	4404	0	0	5	370
Spinner dolphin																	0	2	289	20624
Striped dolphin	0	8	839	75409	0	0	1	61	0	0	0	0	0	2	10	94213	0	0	58	4133
White beaked dolphin													0	0	1	3449				
Beaked whale	0	0	8	771	0	0	5	423	0	0	19	1731	0	0	0	1787	0	0	2	161
Harbor porpoise													0	0	0	152370				
Bryde's whale																	0	0	0	25
Fin whale**	0	0	1	68	0	0	0	0	0	0	0	0	0	0	0*	802				
Humpback whale**	0	0	4	403	0	0*	6	686	0	0*	19	2371	0	0	0*	702				
Minke whale	0	0	0	21	0	0	0	36	0	0	1	129	0	0	0	228				
North Atlantic right whale**	0	0	1	45	0	0	0*	30	0	0	3	363	0	0	0*	224				
Sei whale**													0	0	0*	1035				
Gray Seal													0	0	31	7828				
Harbor Seal													0	0	29	12630				

* Indicates an exposure greater than or equal to 0.05, therefore, is considered a "may affect" for ESA-listed species.
**Denotes species listed in accordance with the Endangered Species Act.
***Pilot whales include both short- and long-finned pilot whales along the East Coast
****Reflects short-finned pilot whales in the Gulf of Mexico.

This page is intentionally blank.

Table 4-16. Estimated Annual Marine Mammal Exposures From ULT, RDT&E, and Maintenance Active Sonar Activities Under Alternative 1

Species	Atlantic Ocean, Offshore of the Southeastern United States												Northeast				Gulf of Mexico			
	VACAPES OPAREA				CHPT OPAREA				JAX/CHASN OPAREA				Northeast OPAREA				GOMEX			
	Mortality	PTS	TTS	Risk-Function	Mortality	PTS	TTS	Risk-Function	Mortality	PTS	TTS	Risk-Function	Mortality	PTS	TTS	Risk-Function	Mortality	PTS	TTS	Risk-Function
Atlantic spotted dolphin	0	5	516	54803	0	1	132	17028	0	4	667	97904	0	0	4	16504	0	2	12	2051
Atlantic white-sided dolphin													0	0	0	45				
Bottlenose dolphin	0	4	384	40811	0	2	246	33052	0	7	851	133748	0	0	3	23807	0	1	15	4149
Clymene dolphin	0	0	29	3582	0	0	33	4482	0	1	109	15088					0	0	7	734
Common dolphin	0	5	841	69960	0	0	0	0	0	0	0	0	0	1	14	90005				
False killer whale																	0	0	0	44
Fraser's dolphin																	0	0	0	31
Killer whale																	0	0	0	6
Kogia spp.	0	0	3	340	0	0	3	426	0	0	10	1434	0	0	0	547	0	0	0	11
Melon-headed whale																	0	0	1	146
Pantropical spotted dolphin	0	1	60	7497	0	1	69	9381	0	2	228	31581	0	0	1	12057	0	0	12	2157
Pilot whales* **	0	1	115	12364	0	0	34	4651	0	2	243	33375	0	0	12	15866				
Pygmy killer whale																	0	0	0	21
Risso's dolphin	0	0	24	2272	0	0	4	593	0	2	203	27915	0	0	2	15402	0	0	0	74
Rough-toothed dolphin	0	0	1	162	0	0	1	202	0	0	5	681					0	0	0	130
Short-finned pilot whale** **																	0	0	1	101
Sperm whale **	0	0*	17	1880	0	0	2	231	0	0	3	429	0	0	1	2204	0	0	0*	20
Spinner dolphin																	0	0	0	517
Striped dolphin	0	1	81	7274	0	0	0	12	0	0	0	0	0	2	14	169114	0	0	0	126
White beaked dolphin													0	0	1	3306				
Beaked whale	0	0	2	296	0	0	1	80	0	0	4	554	0	0	0	522	0	0	0	3
Harbor porpoise													0	0	0	28				
Bryde's whale																	0	0	0	2
Fin whale **	0	0	1	74	0	0	0	0	0	0	0	0	0	0	0*	382				
Humpback whale **	0	0	2	334	0	0	2	410	0	0*	7	1365	0	0	0*	627				
Minke whale	0	0	0	17	0	0	0	22	0	0	0	73	0	0	0	42				
North Atlantic right whale **	0	0	0*	30	0	0	0	1	0	0	1	110	0	0	0*	58				
Sei whale **													0	0	0*	744				
Gray Seal													0	0	20	1434				
Harbor Seal													0	0	0	749				

* Indicates an exposure greater than or equal to 0.05, therefore, is considered a "may affect" for ESA-listed species.
**Denotes species listed in accordance with the Endangered Species Act.
***Pilot whales include both short- and long-finned pilot whales along the East Coast
****Reflects short-finned pilot whales in the Gulf of Mexico.

This page is intentionally blank.

Table 4-17. Estimated Annual Marine Mammal Exposures From Coordinated ULT Active Sonar Activities Under Alternative 1

Species	Atlantic Ocean, Offshore of the Southeastern United States												Northeast				Gulf of Mexico			
	VACAPES OPAREA				CHPT OPAREA				JAX/CHASN OPAREA				Northeast OPAREA				GOMEX			
	Mortality	PTS	TTS	Risk-Function	Mortality	PTS	TTS	Risk-Function	Mortality	PTS	TTS	Risk-Function	Mortality	PTS	TTS	Risk-Function	Mortality	PTS	TTS	Risk-Function
Atlantic spotted dolphin	0	1	93	4317	0	0	24	1212	0	2	460	24506	0	0	0	141	0	0	0	1908
Atlantic white-sided dolphin													0	0	0	0				
Bottlenose dolphin	0	0	69	3172	0	0	44	2590	0	4	581	37235	0	0	0	214	0	0	2	3423
Clymene dolphin	0	0	5	243	0	0	6	349	0	1	75	5029					0	0	1	119
Common dolphin	0	1	152	5225	0	0	0	0	0	0	0	0	0	0	0	810				
False killer whale																	0	0	0	7
Fraser's dolphin																	0	0	0	5
Killer whale																	0	0	0	1
Kogia spp.	0	0	0	23	0	0	1	33	0	0	7	478	0	0	0	5	0	0	0	1
Melon-headed whale																	0	0	0	24
Pantropical spotted dolphin	0	0	11	509	0	0	12	730	0	1	158	10526	0	0	0	109	0	0	2	167
Pilot whales***	0	0	21	971	0	0	6	375	0	1	169	11586	0	0	0	111				
Pygmy killer whale																	0	0	0	3
Risso's dolphin	0	0	4	175	0	0	1	45	0	1	141	9634	0	0	0	137	0	0	0	11
Rough-toothed dolphin	0	0	0	11	0	0	0	16	0	0	3	227					0	0	0	120
Short-finned pilot whale****																	0	0	0	16
Sperm whale**	0	0	3	149	0	0	0*	18	0	0	2	150	0	0	0	17	0	0	0	2
Spinner dolphin																	0	0	0	55
Striped dolphin	0	0	15	551	0	0	0	1	0	0	0	0	0	0	0	1525	0	0	0	7
White beaked dolphin													0	0	0	29				
Beaked whale	0	0	0	24	0	0	0	6	0	0	3	195	0	0	0	5	0	0	0	0
Harbor porpoise													0	0	0	0				
Bryde's whale																	0	0	0	0
Fin whale**	0	0	0*	6	0	0	0	0	0	0	0	0	0	0	0	2				
Humpback whale**	0	0	0*	24	0	0	0*	34	0	0	5	464	0	0	0	6				
Minke whale	0	0	0	1	0	0	0	2	0	0	0	25	0	0	0	0				
North Atlantic right whale**	0	0	0	1	0	0	0	0*	0	0	0*	26	0	0	0	0				
Sei whale**													0	0	0	6				
Gray Seal													0	0	0	0				
Harbor Seal													0	0	0	0				

* Indicates an exposure greater than or equal to 0.05, therefore, is considered a "may affect" for ESA-listed species.
**Denotes species listed in accordance with the Endangered Species Act.
***Pilot whales include both short- and long-finned pilot whales along the East Coast
****Reflects short-finned pilot whales in the Gulf of Mexico.

This page is intentionally blank.

Table 4-18. Estimated Annual Marine Mammal Exposures From Strike Group Active Sonar Exercises Under Alternative 1

Species	Atlantic Ocean, Offshore of the Southeastern United States												Northeast				Gulf of Mexico			
	VACAPES OPAREA				CHPT OPAREA				JAX/CHASN OPAREA				Northeast OPAREA				GOMEX			
	Mortality	PTS	TTS	Risk-Function	Mortality	PTS	TTS	Risk-Function	Mortality	PTS	TTS	Risk-Function	Mortality	PTS	TTS	Risk-Function	Mortality	PTS	TTS	Risk-Function
Atlantic spotted dolphin	0	1	209	9108	0	1	159	7476	0	1	248	11740	0	0	0	0	0	0	58	3969
Atlantic white-sided dolphin													0	0	0	0				
Bottlenose dolphin	0	1	151	6580	0	2	255	13912	0	3	416	24636	0	0	0	0	0	1	110	7510
Clymene dolphin	0	0	8	377	0	0	42	2336	0	1	73	4450					0	1	105	7198
Common dolphin	0	1	131	5699	0	0	0	0	0	0	0	0	0	0	0	0				
False killer whale																	0	0	6	431
Fraser's dolphin																	0	0	4	301
Killer whale																	0	0	1	55
Kogia spp.	0	0	1	36	0	0	4	222	0	0	7	423	0	0	0	0	0	0	5	354
Melon-headed whale																	0	0	21	1431
Pantropical spotted dolphin	0	0	16	790	0	1	87	4889	0	1	153	9315	0	0	0	0	0	5	735	50171
Pilot whales* **	0	0	42	1886	0	0	34	1989	0	1	158	9823	0	0	0	0				
Pygmy killer whale																	0	0	3	206
Risso's dolphin	0	0	6	268	0	0	6	345	0	1	109	6778	0	0	0	0	0	0	17	1150
Rough-toothed dolphin	0	0	0	17	0	0	2	105	0	0	3	201					0	0	12	806
Short-finned pilot whale** **																	0	0	14	990
Sperm whale **	0	0*	6	291	0	0	3	152	0	0	3	200	0	0	0	0	0	0.03	4	288
Spinner dolphin																	0	1	145	9900
Striped dolphin	0	0	18	787	0	0	0	10	0	0	0	0	0	0	0	0	0	0	46	3179
White beaked dolphin													0	0	0	0				
Beaked whale	0	0	1	41	0	0	1	34	0	0	3	179	0	0	0	0	0	0	2	158
Harbor porpoise													0	0	0	0				
Bryde's whale																	0	0	0	22
Fin whale **	0	0	0	2	0	0	0	0	0	0	0	0	0	0	0	0				
Humpback whale **	0	0	1	36	0	0	3	223	0	0	5	411	0	0	0	0				
Minke whale	0	0	0	2	0	0	0	12	0	0	0	22	0	0	0	0				
North Atlantic right whale **	0	0	0	0*	0	0	0	0*	0	0	0*	12	0	0	0	0				
Sei whale **													0	0	0	0				
Gray Seal													0	0	0	0				
Harbor Seal													0	0	0	0				

* Indicates an exposure greater than or equal to 0.05, therefore, is considered a "may affect" for ESA-listed species.
**Denotes species listed in accordance with the Endangered Species Act.
***Pilot whales include both short- and long-finned pilot whales along the East Coast
****Reflects short-finned pilot whales in the Gulf of Mexico.

This page is intentionally blank.

Table 4-19. Estimated Annual Marine Mammal Exposures From ULT, RDT&E, Maintenance, Coordinated ULT, and Strike Group Active Sonar Activities Under Alternative 1

Species	Atlantic Ocean, Offshore of the Southeastern United States												Northeast				Gulf of Mexico			
	VACAPES OPAREA				CHPT OPAREA				JAX/CHASN OPAREA				Northeast OPAREA				GOMEX			
	Mortality	PTS	TTS	Risk-Function	Mortality	PTS	TTS	Risk-Function	Mortality	PTS	TTS	Risk-Function	Mortality	PTS	TTS	Risk-Function	Mortality	PTS	TTS	Risk-Function
Atlantic spotted dolphin	0	7	818	68228	0	2	315	25716	0	7	1375	134150	0	0	4	16645	0	3	70	7928
Atlantic white-sided dolphin													0	0	0	46				
Bottlenose dolphin	0	5	604	50564	0	5	546	49554	0	15	1848	195619	0	0	3	24021	0	1	127	15082
Clymene dolphin	0	0	42	4202	0	1	80	7166	0	2	257	24567					0	1	114	8052
Common dolphin	0	7	1124	80884	0	0	0	1	0	0	0	0	0	1	14	90815				
False killer whale																	0	0	7	482
Fraser's dolphin																	0	0	5	337
Killer whale																	0	0	1	62
Kogia spp.	0	0	4	399	0	0	8	681	0	0	24	2334	0	0	0	552	0	0	5	365
Melon-headed whale																	0	0	23	1601
Pantropical spotted dolphin	0	1	87	8795	0	1	168	15000	0	5	539	51422	0	0	1	12166	0	6	749	52495
Pilot whales* **	0	2	178	15221	0	1	74	7014	0	5	569	54784	0	0	12	15977				
Pygmy killer whale																	0	0	3	230
Risso's dolphin	0	0	34	2715	0	0	12	982	0	4	454	44326	0	0	2	15540	0	0	17	1235
Rough-toothed dolphin	0	0	2	190	0	0	4	324	0	0	12	1109					0	0	12	1057
Short-finned pilot whale****																	0	0	16	1108
Sperm whale**	0	0*	26	2320	0	0	5	402	0	0*	9	779	0	0	1	2221	0	0	4	310
Spinner dolphin																	0	1	145	10472
Striped dolphin	0	1	113	8613	0	0	0	23	0	0	0	0	0	2	14	170639	0	0	46	3311
White beaked dolphin													0	0	1	3335				
Beaked whale	0	0	4	361	0	0	1	120	0	0	10	928	0	0	0	527	0	0	2	161
Harbor porpoise													0	0	0	28				
Bryde's whale																	0	0	0	25
Fin whale**	0	0	1	81	0	0	0	0	0	0	0	0	0	0	0*	384				
Humpback whale**	0	0	3	394	0	0*	6	667	0	0*	18	2240	0	0	0*	633				
Minke whale	0	0	0	21	0	0	0	35	0	0	1	121	0	0	0	42				
North Atlantic right whale**	0	0	0*	32	0	0	0	1	0	0	1	148	0	0	0*	58				
Sei whale**													0	0	0*	750				
Gray Seal													0	0	20	1434				
Harbor Seal													0	0	0	749				

* Indicates an exposure greater than or equal to 0.05, therefore, is considered a "may affect" for ESA-listed species.
**Denotes species listed in accordance with the Endangered Species Act.
***Pilot whales include both short- and long-finned pilot whales along the East Coast
****Reflects short-finned pilot whales in the Gulf of Mexico.

This page is intentionally blank.

Table 4-20. Estimated Annual Marine Mammal Exposures From ULT, RDT&E, and Maintenance Active Sonar Activities Under Alternative 2

Species	Atlantic Ocean, Offshore of the Southeastern United States												Northeast				Gulf of Mexico			
	VACAPES OPAREA				CHPT OPAREA				JAX/CHASN OPAREA				Northeast OPAREA				GOMEX			
	Mortality	PTS	TTS	Risk-Function	Mortality	PTS	TTS	Risk-Function	Mortality	PTS	TTS	Risk-Function	Mortality	PTS	TTS	Risk-Function	Mortality	PTS	TTS	Risk-Function
Atlantic spotted dolphin	0	5	509	54024	0	1	132	16991	0	4	685	100395	0	0	4	16504	0	2	12	2051
Atlantic white-sided dolphin													0	0	0	45				
Bottlenose dolphin	0	3	337	35566	0	3	264	35972	0	9	1007	151816	0	0	3	23807	0	1	15	4149
Clymene dolphin	0	0	29	3582	0	0	33	4482	0	1	109	15088					0	0	7	734
Common dolphin	0	5	783	63452	0	0	0	0	0	0	0	0	0	1	14	90005				
False killer whale																	0	0	0	44
Fraser's dolphin																	0	0	0	31
Killer whale																	0	0	0	6
Kogia spp.	0	0	3	340	0	0	3	426	0	0	10	1434	0	0	0	547	0	0	0	11
Melon-headed whale																	0	0	1	146
Pantropical spotted dolphin	0	1	60	7497	0	1	69	9381	0	2	228	31581	0	0	1	12057	0	0	12	2157
Pilot whales* **	0	1	103	10946	0	0	35	4745	0	3	269	36953	0	0	12	15866				
Pygmy killer whale																	0	0	0	21
Risso's dolphin	0	0	25	2377	0	0	13	2029	0	2	235	32464	0	0	2	15402	0	0	0	74
Rough-toothed dolphin	0	0	1	162	0	0	1	202	0	0	5	681					0	0	0	130
Short-finned pilot whale****																	0	0	1	101
Sperm whale**	0	0*	16	1761	0	0	2	228	0	0	3	455	0	0	1	2204	0	0	0*	20
Spinner dolphin																	0	0	0	517
Striped dolphin	0	1	84	7586	0	0	0	12	0	0	0	0	0	2	14	169114	0	0	0	126
White beaked dolphin													0	0	1	3306	0	0	0	0
Beaked whale	0	0	2	215	0	0	1	77	0	0	4	493	0	0	0	522	0	0	0	3
Harbor porpoise													0	0	0	28	0	0	0	0
Bryde's whale													0	0	0	0	0	0	0	2
Fin whale**	0	0	1	74	0	0	0	0	0	0	0	0	0	0	0*	382				
Humpback whale**	0	0	2	334	0	0	2	410	0	0*	7	1365	0	0	0*	627				
Minke whale	0	0	0	17	0	0	0	22	0	0	0	73	0	0	0	42				
North Atlantic right whale**	0	0	0*	30	0	0	0	1	0	0	1	110	0	0	0*	58				
Sei whale**													0	0	0*	744				
Gray Seal													0	0	20	1434				
Harbor Seal													0	0	0	749				

* Indicates an exposure greater than or equal to 0.05, therefore, is considered a "may affect" for ESA-listed species.
**Denotes species listed in accordance with the Endangered Species Act.
***Pilot whales include both short- and long-finned pilot whales along the East Coast
****Reflects short-finned pilot whales in the Gulf of Mexico.

This page is intentionally blank.

Table 4-21. Estimated Annual Marine Mammal Exposures From Coordinated ULT Active Sonar Activities Under Alternative 2

Species	Atlantic Ocean, Offshore of the Southeastern United States												Northeast				Gulf of Mexico			
	VACAPES OPAREA				CHPT OPAREA				JAX/CHASN OPAREA				Northeast OPAREA				GOMEX			
	Mortality	PTS	TTS	Risk-Function	Mortality	PTS	TTS	Risk-Function	Mortality	PTS	TTS	Risk-Function	Mortality	PTS	TTS	Risk-Function	Mortality	PTS	TTS	Risk-Function
Atlantic spotted dolphin	0	1	92	4254	0	0	24	1209	0	2	473	25387	0	0	0	141	0	0	0	1908
Atlantic white-sided dolphin													0	0	0	0				
Bottlenose dolphin	0	0	61	2751	0	0	47	2828	0	5	689	43869	0	0	0	214	0	0	2	3423
Clymene dolphin	0	0	5	243	0	0	6	349	0	1	75	5029					0	0	1	119
Common dolphin	0	1	142	4704	0	0	0	0	0	0	0	0	0	0	0	810				
False killer whale																	0	0	0	7
Fraser's dolphin																	0	0	0	5
Killer whale																	0	0	0	1
Kogia spp.	0	0	0	23	0	0	1	33	0	0	7	478	0	0	0	5	0	0	0	1
Melon-headed whale																	0	0	0	24
Pantropical spotted dolphin	0	0	11	509	0	0	12	730	0	1	158	10526	0	0	0	109	0	0	2	167
Pilot whales* **	0	0	19	855	0	0	6	382	0	2	187	12848	0	0	0	111				
Pygmy killer whale																	0	0	0	3
Risso’s dolphin	0	0	4	184	0	0	2	162	0	1	163	11224	0	0	0	137	0	0	0	11
Rough-toothed dolphin	0	0	0	11	0	0	0	16	0	0	3	227					0	0	0	120
Short-finned pilot whale******																	0	0	0	16
Sperm whale**	0	0	3	139	0	0	0*	18	0	0	2	159	0	0	0	17	0	0	0	2
Spinner dolphin																	0	0	0	55
Striped dolphin	0	0	15	576	0	0	0	1	0	0	0	0	0	0	0	1525	0	0	0	7
White beaked dolphin													0	0	0	29				
Beaked whale	0	0	0	17	0	0	0	6	0	0	3	173	0	0	0	5	0	0	0	0
Harbor porpoise													0	0	0	0				
Bryde's whale																	0	0	0	0
Fin whale**	0	0	0*	6	0	0	0	0	0	0	0	0	0	0	0	2				
Humpback whale**	0	0	0*	24	0	0	0*	34	0	0	5	464	0	0	0	6				
Minke whale	0	0	0	1	0	0	0	2	0	0	0	25	0	0	0	0				
North Atlantic right whale**	0	0	0	1	0	0	0	0*	0	0	0*	26	0	0	0	0				
Sei whale**													0	0	0	6				
Gray Seal													0	0	0	0				
Harbor Seal													0	0	0	0				

* Indicates an exposure greater than or equal to 0.05, therefore, is considered a “may affect” for ESA-listed species.
**Denotes species listed in accordance with the Endangered Species Act.
***Pilot whales include both short- and long-finned pilot whales along the East Coast
****Reflects short-finned pilot whales in the Gulf of Mexico.

This page is intentionally blank.

Table 4-22. Estimated Annual Marine Mammal Exposures From Strike Group Active Sonar Exercises Under Alternative 2

Species	Atlantic Ocean, Offshore of the Southeastern United States												Northeast				Gulf of Mexico			
	VACAPES OPAREA				CHPT OPAREA				JAX/CHASN OPAREA				Northeast OPAREA				GOMEX			
	Mortality	PTS	TTS	Risk-Function	Mortality	PTS	TTS	Risk-Function	Mortality	PTS	TTS	Risk-Function	Mortality	PTS	TTS	Risk-Function	Mortality	PTS	TTS	Risk-Function
Atlantic spotted dolphin	0	1	92	4260	0	0	24	1214	0	2	473	25394	0	0	0	141	0	0	0	1910
Atlantic white-sided dolphin													0	0	0	0				
Bottlenose dolphin	0	0	61	2755	0	0	47	2835	0	5	689	43881	0	0	0	214	0	0	2	3426
Clymene dolphin	0	0	5	243	0	0	6	350	0	1	75	5031					0	0	1	122
Common dolphin	0	1	142	4707	0	0	0	0	0	0	0	0	0	0	0	810				
False killer whale																	0	0	0	7
Fraser's dolphin																	0	0	0	5
Killer whale																	0	0	0	1
Kogia spp.	0	0	0	23	0	0	1	33	0	0	7	478	0	0	0	5	0	0	0	1
Melon-headed whale																	0	0	0	24
Pantropical spotted dolphin	0	0	11	509	0	0	12	732	0	1	158	10530	0	0	0	109	0	0	2	185
Pilot whales***	0	0	19	856	0	0	6	383	0	2	187	12852	0	0	0	111				
Pygmy killer whale																	0	0	0	3
Risso's dolphin	0	0	4	184	0	0	2	162	0	1	163	11227	0	0	0	137	0	0	0	11
Rough-toothed dolphin	0	0	0	11	0	0	0	16	0	0	3	227					0	0	0	121
Short-finned pilot whale****																	0	0	0	17
Sperm whale**	0	0	3	139	0	0	**0***	18	0	0	2	159	0	0	0	17	0	0	0	2
Spinner dolphin																	0	0	0	59
Striped dolphin	0	0	15	576	0	0	0	1	0	0	0	0	0	0	0	1525	0	0	0	8
White beaked dolphin													0	0	0	29				
Beaked whale	0	0	0	17	0	0	0	6	0	0	3	173	0	0	0	5	0	0	0	0
Harbor porpoise													0	0	0	0				
Bryde's whale																	0	0	0	0
Fin whale**	0	0	**0***	6	0	0	0	0	0	0	0	0	0	0	0	2				
Humpback whale**	0	0	0	24	0	0	0	34	0	0	5	465	0	0	0	6				
Minke whale	0	0	0	1	0	0	0	2	0	0	0	25	0	0	0	0				
North Atlantic right whale**	0	0	0	1	0	0	0	**0***	0	0	**0***	26	0	0	0	0				
Sei whale**													0	0	0	6				
Gray Seal													0	0	0	0				
Harbor Seal													0	0	0	0				

* Indicates an exposure greater than or equal to 0.05, therefore, is considered a "may affect" for ESA-listed species.
**Denotes species listed in accordance with the Endangered Species Act.
***Pilot whales include both short- and long-finned pilot whales along the East Coast
****Reflects short-finned pilot whales in the Gulf of Mexico.

This page is intentionally blank.

Table 4-23. Estimated Annual Marine Mammal Exposures From ULT, RDT&E, Maintenance, Coordinated ULT, and Strike Group Active Sonar Activities Under Alternative 2

Species	Atlantic Ocean, Offshore of the Southeastern United States												Northeast				Gulf of Mexico			
	VACAPES OPAREA				CHPT OPAREA				JAX/CHASN OPAREA				Northeast OPAREA				GOMEX			
	Mortality	PTS	TTS	Risk-Function	Mortality	PTS	TTS	Risk-Function	Mortality	PTS	TTS	Risk-Function	Mortality	PTS	TTS	Risk-Function	Mortality	PTS	TTS	Risk-Function
Atlantic spotted dolphin	0	6	693	62538	0	1	180	19414	0	9	1631	151176	0	0	4	16786	0	2	12	5869
Atlantic white-sided dolphin													0	0	0	46				
Bottlenose dolphin	0	4	459	41072	0	3	359	41635	0	19	2385	239566	0	0	3	24234	0	1	20	10997
Clymene dolphin	0	0	39	4068	0	0	45	5180	0	2	260	25147					0	0	10	975
Common dolphin	0	6	1066	72863	0	0	0	0	0	0	0	0	0	1	14	91625				
False killer whale																	0	0	1	58
Fraser's dolphin																	0	0	0	41
Killer whale																	0	0	0	7
Kogia spp.	0	0	4	386	0	0	4	492	0	0	25	2389	0	0	0	557	0	0	0	13
Melon-headed whale																	0	0	2	194
Pantropical spotted dolphin	0	1	81	8514	0	1	93	10843	0	5	543	52636	0	0	1	12275	0	0	16	2509
Pilot whales* **	0	1	141	12656	0	0	47	5510	0	6	642	62653	0	0	12	16089				
Pygmy killer whale																	0	0	0	28
Risso’s dolphin	0	0	33	2745	0	0	18	2353	0	5	561	54915	0	0	2	15677	0	0	1	96
Rough-toothed dolphin	0	0	2	184	0	0	2	234	0	0	12	1136					0	0	0	371
Short-finned pilot whale****																	0	0	1	134
Sperm whale**	0	**0***	22	2039	0	0	2	264	0	**0***	8	772	0	0	1	2237	0	0	**0***	25
Spinner dolphin																	0	0	0	631
Striped dolphin	0	1	114	8738	0	0	0	14	0	0	0	0	0	2	14	172164	0	0	0	140
White beaked dolphin													0	0	1	3364				
Beaked whale	0	0	2	250	0	0	1	89	0	0	9	839	0	0	0	532	0	0	0	3
Harbor porpoise													0	0	0	28				
Bryde's whale																	0	0	0	3
Fin whale**	0	0	1	85	0	0	0	0	0	0	0	0	0	0	**0***	386				
Humpback whale**	0	0	3	381	0	0	3	477	0	**0***	18	2294	0	0	**0***	639				
Minke whale	0	0	0	20	0	0	0	25	0	0	1	124	0	0	0	42				
North Atlantic right whale**	0	0	**0***	32	0	0	0	1	0	0	1	148	0	0	**0***	58				
Sei whale**													0	0	**0***	756				
Gray Seal													0	0	20	1434				
Harbor Seal													0	0	0	749				

* Indicates an exposure greater than or equal to 0.05, therefore, is considered a “may affect” for ESA-listed species.
**Denotes species listed in accordance with the Endangered Species Act.
***Pilot whales include both short- and long-finned pilot whales along the East Coast
****Reflects short-finned pilot whales in the Gulf of Mexico.

This page is intentionally blank.

Table 4-24. Estimated Annual Marine Mammal Exposures From ULT, RDT&E, and Maintenance Active Sonar Activities Under Alternative 3

Species	Atlantic Ocean, Offshore of the Southeastern United States												Northeast				Gulf of Mexico			
	VACAPES OPAREA				CHPT OPAREA				JAX/CHASN OPAREA				Northeast OPAREA				GOMEX			
	Mortality	PTS	TTS	Risk-Function	Mortality	PTS	TTS	Risk-Function	Mortality	PTS	TTS	Risk-Function	Mortality	PTS	TTS	Risk-Function	Mortality	PTS	TTS	Risk-Function
Atlantic spotted dolphin	0	4	482	50825	0	1	241	25266	0	6	1291	166087	0	0	3	9345	0	2	12	6282
Atlantic white-sided dolphin													0	0	1	20277				
Bottlenose dolphin	0	1	112	12638	0	3	261	35227	0	16	1893	269804	0	0	2	12874	0	1	15	7811
Clymene dolphin	0	0	34	3754	0	0	38	4757	0	1	122	16510					0	0	7	740
Common dolphin	0	1	242	15541	0	0	1	72	0	0	0	0	0	1	11	55121				
False killer whale																	0	0	0	44
Fraser's dolphin																	0	0	0	31
Killer whale																	0	0	0	6
Kogia spp.	0	0	3	357	0	0	4	452	0	0	12	1569	0	0	0	397	0	0	0	12
Melon-headed whale																	0	0	1	147
Pantropical spotted dolphin	0	1	72	7858	0	1	79	9957	0	2	256	34559	0	0	1	8676	0	0	11	2005
Pilot whales* **	0	1	66	7526	0	1	44	6361	0	3	323	45539	0	0	13	22883				
Pygmy killer whale																	0	0	0	21
Risso's dolphin	0	0	35	3539	0	0	53	6711	0	2	266	36465	0	0	2	16881	0	0	0	96
Rough-toothed dolphin	0	0	2	170	0	0	2	215	0	0	6	746					0	0	0	131
Short-finned pilot whale****																	0	0	1	102
Sperm whale**	0	0*	13	1514	0	0	1	174	0	0*	6	840	0	0	1	4336	0	0	0*	19
Spinner dolphin																	0	0	0	905
Striped dolphin	0	3	251	30679	0	0	0	32	0	0	0	0	0	1	8	76622	0	0	0	184
White beaked dolphin													0	0	1	3378				
Beaked whale	0	0	4	526	0	0	2	274	0	0	7	996	0	0	0	560	0	0	0	1
Harbor porpoise													0	0	0	151391				
Bryde's whale																	0	0	0	2
Fin whale**	0	0	1	51	0	0	0	0	0	0	0	0	0	0	0*	646				
Humpback whale**	0	0	3	349	0	0	3	433	0	0*	8	1484	0	0	0*	623				
Minke whale	0	0	0	18	0	0	0	23	0	0	0	80	0	0	0	286				
North Atlantic right whale**	0	0	0*	45	0	0	0*	23	0	0	2	277	0	0	0*	163				
Sei whale**													0	0	0*	716				
Gray Seal													0	0	33	8347				
Harbor Seal													0	0	0	12562				

* Indicates an exposure greater than or equal to 0.05, therefore, is considered a "may affect" for ESA-listed species.
**Denotes species listed in accordance with the Endangered Species Act.
***Pilot whales include both short- and long-finned pilot whales along the East Coast
****Reflects short-finned pilot whales in the Gulf of Mexico.

This page is intentionally blank.

Table 4-25. Estimated Annual Marine Mammal Exposures From Coordinated ULT Active Sonar Activities Under Alternative 3

Species	Atlantic Ocean, Offshore of the Southeastern United States												Northeast				Gulf of Mexico			
	VACAPES OPAREA				CHPT OPAREA				JAX/CHASN OPAREA				Northeast OPAREA				GOMEX			
	Mortality	PTS	TTS	Risk-Function	Mortality	PTS	TTS	Risk-Function	Mortality	PTS	TTS	Risk-Function	Mortality	PTS	TTS	Risk-Function	Mortality	PTS	TTS	Risk-Function
Atlantic spotted dolphin	0	1	87	3951	0	0	44	1708	0	4	897	42521	0	0	0	74	0	0	0	1908
Atlantic white-sided dolphin													0	0	0	183				
Bottlenose dolphin	0	0	20	948	0	0	47	2846	0	9	1306	81882	0	0	0	115	0	0	2	3418
Clymene dolphin	0	0	6	251	0	0	7	365	0	1	85	5273					0	0	1	118
Common dolphin	0	0	44	1129	0	0	0	5	0	0	0	0	0	0	0	495				
False killer whale																	0	0	0	7
Fraser's dolphin																	0	0	0	5
Killer whale																	0	0	0	1
Kogia spp.	0	0	1	24	0	0	1	35	0	0	8	501	0	0	0	4	0	0	0	1
Melon-headed whale																	0	0	0	24
Pantropical spotted dolphin	0	0	13	526	0	0	14	764	0	1	178	11038	0	0	0	78	0	0	2	147
Pilot whales* **	0	0	12	587	0	0	8	522	0	2	224	15800	0	0	0	167				
Pygmy killer whale																	0	0	0	3
Risso's dolphin	0	0	6	274	0	0	10	520	0	1	185	12420	0	0	0	150	0	0	0	10
Rough-toothed dolphin	0	0	0	11	0	0	0	16	0	0	4	238					0	0	0	120
Short-finned pilot whale****																	0	0	0	16
Sperm whale**	0	0	2	119	0	0	0*	14	0	0	4	284	0	0	0	35	0	0	0	2
Spinner dolphin																	0	0	0	55
Striped dolphin	0	0	45	2423	0	0	0	3	0	0	0	0	0	0	0	691	0	0	0	7
White beaked dolphin													0	0	0	30				
Beaked whale	0	0	1	42	0	0	0	22	0	0	5	341	0	0	0	5	0	0	0	0
Harbor porpoise													0	0	0	1315				
Bryde's whale																	0	0	0	0
Fin whale**	0	0	0*	4	0	0	0	0	0	0	0	0	0	0	0	4				
Humpback whale**	0	0	0*	24	0	0	0*	35	0	0	6	487	0	0	0	6				
Minke whale	0	0	0	1	0	0	0	2	0	0	0	27	0	0	0	2				
North Atlantic right whale**	0	0	0*	2	0	0	0	2	0	0	1	72	0	0	0	1				
Sei whale**													0	0	0	6				
Gray Seal													0	0	0	59				
Harbor Seal													0	0	0	105				

* Indicates an exposure greater than or equal to 0.05, therefore, is considered a "may affect" for ESA-listed species.
**Denotes species listed in accordance with the Endangered Species Act.
***Pilot whales include both short- and long-finned pilot whales along the East Coast
****Reflects short-finned pilot whales in the Gulf of Mexico.

This page is intentionally blank.

Table 4-26. Estimated Annual Marine Mammal Exposures From Strike Group Active Sonar Exercises Under Alternative 3

Species	Atlantic Ocean, Offshore of the Southeastern United States												Northeast				Gulf of Mexico			
	VACAPES OPAREA				CHPT OPAREA				JAX/CHASN OPAREA				Northeast OPAREA				GOMEX			
	Mortality	PTS	TTS	Risk-Function	Mortality	PTS	TTS	Risk-Function	Mortality	PTS	TTS	Risk-Function	Mortality	PTS	TTS	Risk-Function	Mortality	PTS	TTS	Risk-Function
Atlantic spotted dolphin	0	1	182	8187	0	1	166	6317	0	1	246	10468	0	0	0	0	0	1	95	5236
Atlantic white-sided dolphin													0	0	0	0				
Bottlenose dolphin	0	0	46	2085	0	2	285	16868	0	7	936	57371	0	0	0	0	0	2	247	15777
Clymene dolphin	0	0	9	393	0	0	43	2349	0	1	73	4392					0	1	105	7164
Common dolphin	0	0	43	1180	0	0	0	16	0	0	0	0	0	0	0	0				
False killer whale																	0	0	6	429
Fraser's dolphin																	0	0	4	300
Killer whale																	0	0	1	55
Kogia spp.	0	0	1	37	0	0	4	223	0	0	7	417	0	0	0	0	0	0	5	352
Melon-headed whale																	0	0	21	1425
Pantropical spotted dolphin	0	0	19	823	0	1	89	4916	0	1	153	9192	0	0	0	0	0	4	622	42234
Pilot whales* **	0	0	26	1201	0	0	56	3487	0	2	251	15886	0	0	0	0				
Pygmy killer whale																	0	0	3	205
Risso's dolphin	0	0	11	470	0	0	53	2936	0	1	151	9549	0	0	0	0	0	0	27	1817
Rough-toothed dolphin	0	0	0	18	0	0	2	106	0	0	3	198					0	0	3	173
Short-finned pilot whale****																	0	0	14	986
Sperm whale**	0	0	5	228	0	0	2	121	0	0*	7	394	0	0	0	0	0	0	4	249
Spinner dolphin																	0	2	288	19620
Striped dolphin	0	1	68	3431	0	0	0	26	0	0	0	0	0	0	0	0	0	1	80	5443
White beaked dolphin													0	0	0	0				
Beaked whale	0	0	1	64	0	0	3	152	0	0	7	394	0	0	0	0	0	0	0	26
Harbor porpoise													0	0	0	0				
Bryde's whale																	0	0	0	22
Fin whale**	0	0	0*	4	0	0	0	0	0	0	0	0	0	0	0	0				
Humpback whale**	0	0	1	38	0	0	3	223	0	0	5	409	0	0	0	0				
Minke whale	0	0	0	2	0	0	0	12	0	0	0	22	0	0	0	0				
North Atlantic right whale**	0	0	0*	2	0	0	0*	5	0	0	0*	16	0	0	0	0				
Sei whale**													0	0	0	0				
Gray Seal													0	0	0	0				
Harbor Seal													0	0	0	0				

* Indicates an exposure greater than or equal to 0.05, therefore, is considered a "may affect" for ESA-listed species.
**Denotes species listed in accordance with the Endangered Species Act.
***Pilot whales include both short- and long-finned pilot whales along the East Coast
****Reflects short-finned pilot whales in the Gulf of Mexico.

This page is intentionally blank.

Table 4-27. Estimated Annual Marine Mammal Exposures From ULT, RDT&E, Maintenance, Coordinated ULT, and Strike Group Active Sonar Activities Under Alternative 3

Species	Atlantic Ocean, Offshore of the Southeastern United States												Northeast				Gulf of Mexico			
	VACAPES OPAREA				CHPT OPAREA				JAX/CHASN OPAREA				Northeast OPAREA				GOMEX			
	Mortality	PTS	TTS	Risk-Function	Mortality	PTS	TTS	Risk-Function	Mortality	PTS	TTS	Risk-Function	Mortality	PTS	TTS	Risk-Function	Mortality	PTS	TTS	Risk-Function
Atlantic spotted dolphin	0	6	750	62964	0	2	450	33292	0	11	2433	219076	0	0	3	9419	0	3	108	13426
Atlantic white-sided dolphin													0	0	1	20460				
Bottlenose dolphin	0	2	178	15671	0	5	592	54941	0	32	4135	409057	0	0	2	12989	0	2	264	27006
Clymene dolphin	0	0	50	4399	0	1	87	7471	0	2	281	26175					0	1	114	8023
Common dolphin	0	1	329	17849	0	0	1	92	0	0	0	0	0	1	11	555616				
False killer whale																	0	0	7	480
Fraser's dolphin																	0	0	5	336
Killer whale																	0	0	1	61
Kogia spp.	0	0	5	418	0	0	8	710	0	0	27	2487	0	0	0	401	0	0	5	364
Melon-headed whale																	0	0	23	1595
Pantropical spotted dolphin	0	1	104	9207	0	2	182	15637	0	5	587	54789	0	0	1	8755	0	5	634	44386
Pilot whales* **	0	1	104	9314	0	1	108	10369	0	7	799	77225	0	0	13	23049				
Pygmy killer whale																	0	0	3	229
Risso's dolphin	0	0	52	4283	0	1	116	10167	0	5	602	58435	0	0	2	17031	0	0	27	1924
Rough-toothed dolphin	0	0	2	199	0	0	4	337	0	0	13	1182					0	0	3	424
Short-finned pilot whale****																	0	0	16	1104
Sperm whale**	0	0*	20	1862	0	0	4	309	0	0*	17	1517	0	0	1	4371	0	0	4	270
Spinner dolphin																	0	2	288	20580
Striped dolphin	0	4	364	36533	0	0	1	61	0	0	0	0	0	1	8	77313	0	1	80	5633
White beaked dolphin													0	0	1	3408				
Beaked whale	0	0	6	632	0	0	5	449	0	0	19	1731	0	0	0	565	0	0	0	26
Harbor porpoise													0	0	0	152706				
Bryde's whale																	0	0	0	25
Fin whale**	0	0	1	59	0	0	0	0	0	0	0	0	0	0	0*	650				
Humpback whale**	0	0	4	411	0	0*	6	691	0	0*	19	2381	0	0	0*	629				
Minke whale	0	0	0	21	0	0	0	37	0	0	1	129	0	0	0	289				
North Atlantic right whale**	0	0	1	49	0	0	0*	30	0	0	3	366	0	0	0*	164				
Sei whale**													0	0	0*	722				
Gray Seal													0	0	34	8406				
Harbor Seal													0	0	0	12667				

* Indicates an exposure greater than or equal to 0.05, therefore, is considered a "may affect" for ESA-listed species.
**Denotes species listed in accordance with the Endangered Species Act.
***Pilot whales include both short- and long-finned pilot whales along the East Coast
****Reflects short-finned pilot whales in the Gulf of Mexico.

This page is intentionally blank.

4.4.10 Potential Acoustic Effects by Marine Mammal Species

4.4.10.1 Multiple Exposures to an Individual

Each predicted exposure represents a physiological effect or behavioral harassment to a single animal during a given sonar activity. In some instances the same animal could be exposed multiple times during a year, whereas some animals may not be exposed at all. It is not possible to accurately predict the number of individual animals exposed in a year or the number of exposures an individual may receive. Therefore, tables 4-11 through 4-26 show the cumulative number of exposures to a given species due to multiple sonar activities conducted over a single year.

4.4.10.2 Interpreting the Results of the Acoustical Analysis

Because of limited data about how sonar and explosive noise affects some marine mammals, and a complete lack of data for many other species, there is scientific uncertainty with the interpretation of marine mammal acoustic analysis results. A group of acoustic research experts recently developed an outline to help determine potential acoustic effects to specific groups of marine mammals based on their generalized hearing range. This work was presented in Southall et al. (2007). The following subsections are largely based on that work and help to provide a link between the conceptual framework presented in Section 4.4.3 and the results from the acoustic analysis presented in Tables 4-11 through 4-26. This aids in understanding the range of marine mammal reactions that are represented by the calculated results of the acoustic analysis.

4.4.10.2.1 Functional Hearing Groups

Southall et al. (2007) categorized cetaceans into functional hearing groups. Each species should hear within the range of functional hearing for their group, but not necessarily over the entire range. In general, marine mammals do not hear equally well at all frequencies over their entire functional hearing range. Generalized frequency-weighted functions are used to quantitatively characterize the best hearing range within the functional hearing range. When considered in the context of functional hearing groups certain species in the Study Area would be more apt to hear mid- and high-frequency sonar and therefore exhibit behavioral responses. It should be noted that in Southall et al, (2007) functional hearing frequency ranges are different than those ranges used by the Navy to classify their active sonar frequency ranges (i.e. in terms of sonar, the Navy considers 1 kHz to 10 kHz mid-frequency, and 10 kHz to 200 kHz high-frequency). The functional groups and associated frequencies as described in Southall et al. (2007) are as follows:

Low frequency cetaceans - (13 species of mysticetes) functional hearing is estimated to occur between approximately 7 Hz and 22 kHz.

Mid-frequency cetaceans - (32 species of dolphins, six species of larger toothed whales, and 19 species of beaked and bottlenose whales) functional hearing is estimated to occur between approximately 150 Hz and 160 kHz.

High frequency cetaceans - (eight species of true porpoises, six species of river dolphins, Kogia, the franciscana, and four species of cephalorhynchids) functional hearing is estimated to occur between approximately 200 Hz and 180 kHz.

Pinnipeds in water - functional hearing is estimated to occur between approximately 75 Hz and 75 kHz, with the greatest sensitivity between approximately 700 Hz and 20 kHz.

Pinnipeds in air - functional hearing is estimated to occur between approximately 75 Hz and 30 kHz. The effects to pinnipeds in air are not addressed because sonar is only used underwater and sounds travel very poorly from water into air. The acoustic analysis assumes all pinnipeds are in the water (not hauled out) at all times, which likely overestimates effects to pinnipeds.

4.4.10.2.2 Physiological

Physiological effects predicted from AFAST active sonar activities include TTS and PTS. The animals predicted to be in the TTS exposure zone are assumed to experience Level B harassment by virtue of temporary impairment of sensory function that can potentially disrupt behavior. Animals within the PTS zone could experience a permanent shift in hearing capability over a portion of their hearing range. The numbers of marine mammals for all alternatives predicted to experience PTS are comparatively very low versus numbers for TTS exposures. The PTS exposure zones are within 10 m or less of the most powerful sonar sources, and much less for most other sonar sources. Some sources have no PTS zone because their source levels are below PTS criteria. Results from the acoustic analysis of sonar sources likely overestimate PTS effects because mitigation measures are most effective at avoiding exposures close to the source.

Low-frequency cetaceans - Based on the auditory anatomy, low-frequency cetaceans most likely have higher physiological effect thresholds than mid-frequency cetaceans (meaning an animal would need to be closer to the sound source to experience a physiological effect). Therefore, the acoustic analysis may overestimate PTS and TTS for this functional hearing group for almost all AFAST sources (mid-frequency and high-frequency sonar).

Mid-frequency cetaceans – Physiological effect thresholds were derived from mid-frequency cetaceans, and therefore the criteria used in the acoustic analysis are assumed to be good predictors of PTS and TTS for this group.

High-frequency cetaceans - High-frequency cetaceans are considered generally similar to mid-frequency cetaceans, however according to Southall et al. (2007), slightly lower threshold values may be warranted for frequencies above 100 kHz. Therefore, applying mid-frequency criteria to high-frequency cetaceans may underestimate effects for some high-frequency sonars, however few AFAST sources are above 100 kHz and sound above 100 kHz attenuates very rapidly in the water.

Pinnipeds in water – Physiological thresholds in pinnipeds used in this acoustical analysis are derived from the most sensitive species (harbor seals) and are used for the underwater functional hearing range for all species of pinnipeds. This means that the acoustic analysis likely overestimates physiological effects for other species of pinnipeds. Acoustic analysis also likely overestimates effects to pinnipeds because all pinnipeds are assumed to be in the water with no animals hauled-out on the beach.

4.4.10.2.3 Behavioral

Figure 4-6 depicts a severity scale that covers the range of possible behavioral responses a marine mammal could exhibit. Significant behavioral reactions that would constitute a Level B "take" under the MMPA, as clarified under the National Defense Authorization Act, are illustrated as numbers 4 through 9 on the severity scale. A "4" response might include a moderate change in speed or direction with no overt avoidance of the sound source whereas a "9" response could include flight or avoidance of the sound exposure area.

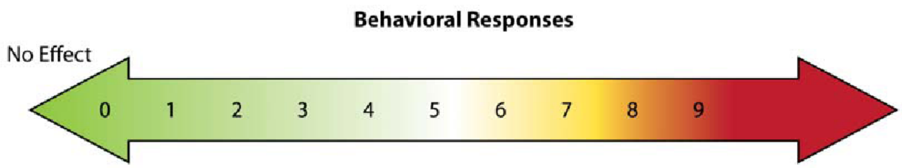
The risk function was developed from limited data and has some inherent scientific uncertainty. It assumes that the likelihood of reaction is not affected by the source frequency and only applies to populations versus individual species. In actuality, the reaction of individual marine mammals to sound likely depends on a number of factors (e.g. activity engaged in during sound exposure, fitness, age, prior experiences, and gender). The most basic factor in determining if a response is likely is the animal's ability to sense the sound, which is dependent on their hearing range and the frequency of sound.

Low-frequency cetaceans - Southall et al. (2007) found that low-frequency cetaceans generally exhibited no (or very limited) responses from non-pulsed (i.e. sonar) signals at received levels of 90 to 120 dB re 1 µPa and an increasing probability of avoidance and other behavioral effects in the 120 to 160 dB re 1 µPa range. Contextual variables, such as source proximity, novelty, and signal characteristics, appeared to be as important as exposure level in predicting response type and severity. Some high-frequency active sonars used in AFAST are above the functional hearing capability of this group and therefore may not elicit a behavioral response. Therefore the acoustic analysis likely overestimates the effects to marine mammals in this functional hearing group (mysticetes).

Mid-frequency cetaceans - Mid-frequency cetacean behavioral responses were more difficult to define (Southall et al., 2007). Within this group, some individuals behaviorally responded with higher severity values at lower received levels than other individuals. Contextual variables other than received exposure levels and species differences within this functional hearing group are likely reasons for the variability in the severity of the response. Animals in this functional hearing group have their best hearing sensitivity within the frequency range of most sources used during AFAST active sonar activities. Therefore, the criteria used in this acoustic analysis are likely to be good predictors of some level of behavioral response for marine mammals in this functional hearing group.

High-frequency cetaceans – Southall et al. (2007) derived high-frequency cetacean behavioral response severity levels from harbor porpoise observations and were applied to all species within this functional group. They considered this a conservative representation for this group, however, there is some inherent uncertainly with the lack of data for other species in this group. Harbor porpoise were found to be quite sensitive to a wide range of human-made sounds at low received levels (90 to 120 dB re 1 µPa) at initial exposure and exhibited profound and sustained avoidance behavior at received levels exceeding 140 dB re 1 µPa. Habituation to sound

This page is intentionally blank.



0	1	2	3	4	5	6	7	8	9
-no observable response	-Brief orientation response (investigation / visual orientation)	-Moderate or multiple orientation behaviors -Brief or minor cessation/ modification of vocal behavior -Brief or minor change in respiration rates	-Prolonged orientation behavior -Individual alert behavior -Minor changes in locomotion speed, direction, and/or dive profile but no avoidance o sound source -Moderate change in respiration rate -Minor cessation or modification of vocal behavior (duration < duration of source operation), including the Lombard Effect	-Moderate changes in locomotion speed, direction, and/or dive profile, but no avoidance of sound source -Brief, minor shift in group distribution -Moderate cessation or modification of vocal behavior (duration approx duration of source operation)	-Extensive or prolonged changes in locomotion speed, direction, and/or dive profile but not avoidance of sound source -Moderate shift in group distribution -Change in inter-animal distance and/or group size (aggregation or separation) -Prolonged cessation or modifications of vocal behavior (duration > duration of source operation)	-Minor or moderate individual and/or group avoidance of sound source -Brief or minor separation of females and dependent offspring -Aggressive behavior related to noise exposure (e.g., tail/flipper slapping, fluke display, jaw clapping/ gnashing teeth, abrupt directed movement, bubble clouds) -Extended cessation or modification of vocal behavior -Visible startle response -Brief cessation of reproductive behavior	-Excessive or prolonged aggressive behavior -Moderate separation of females and dependent offspring -Clear anti-predator response -Severe and/ or sustained avoidance of sound source -Moderate cessation of reproductive behavior	-Obvious aversion and/or progressive sensitization -Prolonged or significant separation of females and dependent offspring with disruption of acoustic reunion mechanisms -Long-term avoidance of area (> source operation) -Prolonged cessation of reproductive behavior	-Outright panic, flight, stampede, attack of conspecifics, or stranding events -Avoidance behavior related to predator detection

As adapted from Southall et al. (2007)

Figure 4-8. Depiction of Severity Scale for Range of Potential Behavioral Responses

This page is intentionally blank.

exposure was noted in some individuals and may occur with repeated exposure and experience with the signal type. Animals in this functional hearing group have their best hearing sensitivity within the frequency range of most sources used during AFAST active sonar activities. Therefore, the criteria used in this acoustic analysis are likely to be good predictors of some level of behavioral response for marine mammals in this functional hearing group.

Pinnipeds in water - Of the limited data available for pinnipeds, Southall et al. (2007) found that most species did not show signs of strong behavioral responses at received levels in the 90 to 140 dB re: 1 µPa range. No behavioral response data exists for received levels above 140 dB re 1 µPa. Captive animals appeared to behaviorally react more strongly at lower received levels than subject animals in the field. Contextual issues might be the cause of the observed difference between captive and field animals. There may have been stronger motivation (i.e. safe location, prey) in the field subjects, causing them to be more tolerant of exposures. Animals in this functional hearing group have their best hearing sensitivity within the frequency range of most sources used during AFAST active sonar activities. Therefore, the criteria used in this acoustic analysis are likely to be good predictors of some level of behavioral response for marine mammals in this functional hearing group. However, acoustic analysis likely overestimates effects to pinnipeds because all pinnipeds are assumed to be in the water with no animals hauled out.

4.4.10.2.4 Masking

Natural and artificial sounds can disrupt behavior by masking, or interfering with an animal's ability to hear other sounds. Masking occurs when the receipt of a sound is interfered with by a second sound at similar frequencies and at similar or higher levels. If the second sound were artificial, it could be potentially harassing if it disrupted hearing-related behavior such as communications or echolocation.

As stated previously, the sonar signals from the proposed AFAST active sonar activities are likely within the hearing range of all four marine mammal functional hearing groups and may mask communication signals between others of the same species. Most of the sounds generated by AFAST active sonar activities have short pulse lengths (on the order of seconds), have low duty cycles (ping only one to a few times per minute, operate within a narrow band of frequencies (typically less than one-third octave), and are transient as a source passes through an area. Because of the intermittent nature and narrow frequency band of most of the sonar transmissions, marine mammals should still be able to hear biologically important sounds from other marine mammals, predators, and environmental cues. For this reason, the chance of sonar operations causing masking effects is considered negligible.

4.4.10.3 Potential Effects to ESA-Listed Species

For the purposes of this section, "active sonar activities" refers to training, maintenance, and RDT&E activities involving mid- and high-frequency active sonar and the explosive source sonobuoy (AN/SSQ-110A).

4.4.10.3.1 North Atlantic Right Whale

Acoustic analysis indicates that up to 666 North Atlantic right whales may be exposed to levels of sound likely to result in Level B harassment under the No Action Alternative, 240 under Alternative 1, 241 under Alternative 2, and 613 under Alternative 3. The exposure estimates for each alternative represents the total number of exposures and not necessarily the number of individuals exposed, as a single individual may be exposed multiple times over the course of a year. Acoustic analysis indicates that no right whales will be exposed to sound levels likely to result in Level A harassment. Modeling of the explosive source sonobuoys (AN/SSQ-110A) predicts no potential for mortality to right whales.

In terms of functional hearing capability right whales belong to low-frequency cetaceans. Right whale functional hearing overlaps with the frequencies produced by mid-frequency and high frequency active sonars. Right whale hearing capability was estimated using a mathematical model which predicted a hearing range of 10 Hz to 22 kHz, and a functional hearing range of 15 Hz to 18 kHz (Parks et al., 2007). Nowacek et al. (2004) noted a response to short tones and down sweeps at 0.5 to 4.5 kHz, but not to vessel noise of 0.05 to 0.5 kHz. Frequencies of high-frequency active sonar above the right whale upper functional hearing range of 18 kHz may not result in a behavioral reaction. Because the acoustic analysis does not consider the specific hearing frequency range of the North Atlantic right whale, the predicted numbers of physiological and behavioral effects are likely to be an overestimate.

Lookouts are more likely to detect a group of North Atlantic right whales on the surface given their large size (Leatherwood and Reeves, 1982), surface behavior, pronounced blow, and group size of two to three animals (larger on feeding grounds) (Wynn and Schwartz, 1999). Implementation of mitigation measures and probability of detecting a large North Atlantic right whale reduce the likelihood of exposure especially for physiological more severe behavioral effects. Refer to Section 5.4 for additional information on mitigation effectiveness. Thus, the number of North Atlantic right whale predicted to experience effects by the acoustic analysis is likely an overestimate.

AFAST sources are transient as active sonar activities pass through an area. Although North Atlantic right whales may exhibit a reaction when exposed to sound from AFAST active sonar activities, the exposures are not expected to be long-term due to the relatively short duration of potential exposures.

The Navy considered potential effects to stocks based on the best abundance estimate for each stock of marine mammal species, as published in the stock assessment report (SAR) by NMFS. Approximately 350 individuals, including about 70 mature females, are thought to occur in the western North Atlantic (Kraus et al., 2005). A May 2007 review of the photo-ID recapture database resulted in a minimum population size of 325 right whales in the Western North Atlantic (Waring et al., 2008). No estimate of abundance with an associated coefficient of variation has been calculated for the population (Waring et al., 2008). Right whales are not expected to occur in the Gulf of Mexico.

Critical habitat for the North Atlantic right whale exists along the U.S. East Coast. The following three areas occur in U.S. waters and were designated by NMFS as critical habitat in June 1994:

(1) Coastal Florida and Georgia (Sebastian Inlet, Florida, to the Altamaha River, Georgia)

(2) The Great South Channel, east of Cape Cod

(3) Cape Cod and Massachusetts Bays

In the southeast North Atlantic right whale critical habitat, no active sonar activities would occur under any alternative with the exception of object detection/navigational sonar training and maintenance activities for surface ships and submarines while entering/exiting ports located in Kings Bay, Georgia, and Mayport, Florida. In addition, helicopter dipping sonar would occur off of Mayport, Florida in the established training areas within the right whale critical habitat. As stated in Chapter 3, the most concentrated densities of North Atlantic right whales are within the migratory corridor. However, with the exception of the limited active sonar activities (i.e., object detection/navigational sonar training, maintenance activities, and helicopter dipping sonar activities), the majority of active sonar activities would occur outside the southeast critical habitat.

In the northeast North Atlantic right whale critical habitat, hull-mounted sonar would not be used, but a limited number of TORPEXs would be conducted in August and September when many North Atlantic right whales have migrated to the south. These TORPEX areas were established during previous ESA Section 7 consultations with NMFS. Under all alternatives, TORPEX activities would not occur within 5 km (2.7 NM) of the Stellwagen Bank National Marine Sanctuary.

The Navy has instituted North Atlantic right whale projective measures that cover vessels operating all along the Atlantic coast in order to reduce the risk of ship strikes. Specifically, standing protective measures and annual guidance have been in place for ships in the vicinity of the North Atlantic right whale critical habitat off the southeast coast since 1997. In 2002, North Atlantic right whale protective measures were promulgated for all United States Fleet Forces (USFF) activities occurring in the northeast region. In December 2004, the Navy issued further guidance for all USFF ships to increase awareness of North Atlantic right whale migratory patterns and implement additional protective measures along the mid-Atlantic coast. This includes areas where ships transit between southern New England and northern Florida. Southward right whale migration generally occurs from mid- to late November, although some right whales may arrive off the Florida coast in early November and stay into late March (Kraus et al., 1993). The northbound migration generally takes place between January and late March. Data indicate that during the spring and fall migration, right whales typically occur in shallow water immediately adjacent to the coast, with over half the sightings (63.8 percent) occurring within 18.5 km (10 NM), and 94.1 percent reported within 55 km (30 NM) of the coast.

Based on best available science, the limited activities conducted in the right whale critical habitat, and the protective measures instituted for North Atlantic right whales, the Navy concludes that exposures to North Atlantic right whales due to AFAST active sonar activities would generally result in short-term effects to individuals exposed and would likely not affect annual rates of recruitment or survival. The mitigations presented in Chapter 5 will further reduce the potential for exposures to occur to North Atlantic right whales.

In accordance with NEPA, there will be no significant impact to North Atlantic right whales from AFAST active sonar activities in territorial waters under the No Action Alternative, Alternative 1, Alternative 2, or Alternative 3. Further, in accordance with EO 12114, there will be no significant harm to North Atlantic right whales from AFAST active sonar activities in non-territorial waters under the No Action Alternative, Alternative 1, Alternative 2, or Alternative 3.

In accordance with the ESA, the Navy finds that AFAST active sonar activities may affect North Atlantic right whales. The Navy initiated consultation with NMFS in accordance with Section 7 of the ESA for concurrence.

4.4.10.3.2 Humpback Whale

Acoustic analysis indicates that up to 4,190 humpback whales may be exposed to levels of sound likely to result in Level B harassment under the No Action Alternative, 3,960 under Alternative 1, 3,815 under Alternative 2, and 4,140 under Alternative 3. The exposure estimates for each alternative represents the total number of exposures and not necessarily the number of individuals exposed, as a single individual may be exposed multiple times over the course of a year. Acoustic analysis indicates that no humpback whales will be exposed to sound levels likely to result in Level A harassment. Modeling of the explosive source sonobuoys (AN/SSQ-110A) predicts no potential for mortality to humpback whales.

Lookouts would likely detect humpback whales at the surface because of their large size (up to 16 m [53 ft]) (Leatherwood and Reeves, 1982), pronounced vertical blow, and group size of 2 to 12 animals (Wynn and Schwartz, 1999). Implementation of mitigation measures and probability of detecting humpback whales reduce the likelihood of exposure and potential effects. Refer to Section 5.4 for additional information on mitigation effectiveness. Thus, the number of humpback whales predicted to experience effects by the acoustic analysis is likely an overestimate.

Humpback whales belong to the low-frequency cetacean functional hearing group. There are no tests or modeling estimates of specific humpback whale hearing ranges. Recent information on the songs of humpback whales suggests that their hearing may extend to frequencies of at least 24 kHz (Au et al., 2006). A single study suggested that humpback whales responded to mid frequency sonar (3.1-3.6 kHz) sound (Maybaum, 1989), however the hand-held sonar system used had a sound artifact below 1,000 Hz which apparently caused a response to the control playback (a blank tape) and may have confounded the results from the treatment (i.e., the humpback whale may have responded to the low frequency artifact rather than the mid-frequency sonar sound). Because the acoustic analysis does not consider the specific hearing frequency range of the humpback whale, the numbers of predicted physiological and behavioral effects are likely to be an overestimate.

AFAST sources are transient as active sonar activities pass through an area. Although humpback whales may exhibit a reaction when exposed to sound from AFAST active sonar activities, the exposures are not expected to be long-term due to the relatively short duration of potential exposures.

The Navy considered potential effects to stocks based on the best available data for each stock of marine mammal species. Humpback whales in the North Atlantic are thought to belong to five different feeding stocks: Gulf of Maine, Gulf of St. Lawrence, Newfoundland/Labrador, western Greenland, and Iceland. Previously, the North Atlantic humpback whale population was treated as a single stock for management purposes (Waring et al., 2008). However, based upon the strong regional fidelity by individual whales the Gulf of Maine has been reclassified as a separate feeding stock (Waring et al., 2008). Recent genetic analyses have also found significant differences in mtDNA haplotype frequencies among whales sampled in four western feeding areas, including the Gulf of Maine (Palsbøll et al., 2001). As a result, the International Whaling Commission acknowledged the evidence for treating the Gulf of Maine as a separate stock for the purpose of management (IWC, 2002). The current best estimate of population size for humpback whales in the North Atlantic, including the Gulf of Maine Stock, is 11,570 individuals (Waring et al., 2008). The best abundance estimate for the Gulf of Maine humpback stock is 847 individuals (Waring et al., 2008). During the winter, most of the North Atlantic population of humpback whales is believed to migrate south to calving grounds in the West Indies region (Whitehead and Moore, 1982; Smith et al., 1999; Stevick et al., 2003). During this time individuals from the various feeding stocks mix through migration routes as well as on the feeding grounds. Additionally, there has been an increasing occurrence of humpbacks, which appear to be primarily juveniles, during the winter along the U.S. Atlantic coast from Florida north to Virginia (Clapham et al., 1993; Swingle et al., 1993; Wiley et al., 1995; Laerm et al., 1997). Although the population composition of the mid-Atlantic is apparently dominated by Gulf of Maine whales, the lack of recent photographic effort in Newfoundland makes it likely that other feeding stocks may be under-represented in the photo identification matching data (Waring et al., 2008). Although the majority of acoustic exposures in the Northeast are likely to be from the Gulf of Maine feeding stock, the mixing of multiple stocks through the migratory season suggests that exposures in the Mid-Atlantic and Southeast are likely spread across all of the North Atlantic populations. Sufficient data to estimate the percentage of exposures to each stock is currently not available.

Based on best available science, the Navy concludes that exposures to humpback whales due to AFAST active sonar activities would generally result in short-term effects to individuals exposed and would likely not affect annual rates of recruitment or survival. The mitigations presented in Chapter 5 will further reduce the potential for exposures to occur to humpback whales.

In accordance with NEPA, there will be no significant impact to humpback whales from AFAST active sonar activities in territorial waters under the No Action Alternative, Alternative 1, Alternative 2, or Alternative 3. Further, in accordance with EO 12114, there will be no significant harm to humpback whales from AFAST active sonar activities in non-territorial waters under the No Action Alternative, Alternative 1, Alternative 2, or Alternative 3.

In accordance with the ESA, the Navy finds the AFAST active sonar activities may affect humpback whales. The Navy initiated consultation with NMFS in accordance with Section 7 of the ESA for concurrence.

4.4.10.3.3 Sei Whale

Acoustic analysis indicates that up to 1,035 sei whales may be exposed to levels of sound likely to result in Level B harassment under the No Action Alternative, 750 under Alternative 1, 756 under Alternative 2, and 722 under Alternative 3. The exposure estimates for each alternative represents the total number of exposures and not necessarily the number of individuals exposed, as a single individual may be exposed multiple times over the course of a year. Acoustic analysis indicates that no sei whales will be exposed to sound levels likely to result in Level A harassment. Modeling of the explosive source sonobuoys (AN/SSQ-110A) predicts no potential for mortality to sei whales.

Sei whales belong to low-frequency cetacean functional hearing group. There are no tests or modeling estimates of specific sei whale hearing ranges. Because the acoustic analysis does not consider the specific hearing frequency range of the sei whale, the numbers of predicted physiological and behavioral effects are likely to be an overestimate.

Lookouts would likely detect sei whales at the surface because they generally form groups of three animals or more, have a pronounced vertical blow, and are large animals (CETAP, 1982; Wynn and Schwartz, 1999). This species may associate on feeding grounds with other readily observable species such as humpback and fin whales (Wynn and Schwartz, 1999). Implementation of mitigation measures and probability of detecting sei whales reduce the likelihood of exposure and potential effects. Refer to Section 5.4 for additional information on mitigation effectiveness. Thus, since they are readily observed and could therefore be avoided, the number of sei whale exposures indicated by the acoustic analysis is likely an overestimate of actual exposures. Thus, the number of sei whale predicted to experience effects by the acoustic analysis is likely an overestimate.

AFAST sources are transient as active sonar activities pass through an area. Although these marine mammals may exhibit a reaction when exposed to sound from AFAST active sonar activities, the exposures are not expected to be long-term due to the relatively short duration of potential exposures.

The Navy considered potential effects to stocks based on the best available data for each stock of marine mammal species. Sei whales in the North Atlantic belong to three stocks: Nova Scotia, Iceland-Denmark Strait, and Northeast Atlantic (Perry et al., 1999). The Nova Scotia Stock that occurs in U.S. Atlantic waters is considered to be the only stock affected by active sonar in U.S. waters (Waring et al., 2008). The boundaries of the Nova Scotian stock of sei whales include the continental shelf waters of the northeastern United States and extends northeastward to the south of Newfoundland (Waring et al., 2008). NMFS adopted the boundaries based on the proposed International Whaling Commission stock definition, which extends from the East Coast to Cape Breton, Nova Scotia, and east to longitude 42 ^{o} W (Waring et al., 1999). The most recent and best available abundance estimate for the Nova Scotia stock is 207 sei whales (Waring et al., 2008).

Based on best available science, the Navy concludes that exposures to sei whales due to AFAST active sonar activities would generally result in short-term effects to individuals exposed and would likely not affect annual rates of recruitment or survival. The mitigations presented in Chapter 5 will further reduce the potential for exposures to occur to sei whales.

In accordance with NEPA, there will be no significant impact to sei whales from AFAST active sonar activities in territorial waters under the No Action Alternative, Alternative 1, Alternative 2, or Alternative 3. Further, in accordance with EO 12114, there will be no significant harm to sei whales from AFAST active sonar activities in non-territorial waters under the No Action Alternative, Alternative 1, Alternative 2, or Alternative 3.

In accordance with the ESA, the Navy finds that AFAST active sonar activities may affect sei whales. The Navy initiated consultation with NMFS in accordance with Section 7 of the ESA for concurrence.

4.4.10.3.4 Fin Whale

Acoustic analysis indicates that up to 871 fin whales may be exposed to levels of sound likely to result in Level B harassment under the No Action Alternative, 467 under Alternative 1, 473 under Alternative 2, and 710 under Alternative 3. The exposure estimates for each alternative represents the total number of exposures and not necessarily the number of individuals exposed, as a single individual may be exposed multiple times over the course of a year. Acoustic analysis indicates that no fin whales will be exposed to sound levels likely to result in Level A harassment. Modeling of the explosive source sonobuoys (AN/SSQ-110A) predicts no potential for mortality to fin whales.

Fin whales belong to the low-frequency functional hearing group. Fin whale calls generally cover the 10 to 20 Hz frequency band and are less than 1 second in duration (Watkins et al, 1987). Because the acoustic analysis does not consider the specific hearing frequency range of the fin whale, the numbers of predicted physiological and behavioral effects are likely to be an overestimate.

Lookouts would likely detect a group of fin whales at the surface because they are large animals, form groups of up to 10 animals, and have a pronounced vertical blow up to six meters in height (Wynn and Schwartz, 1999). Implementation of mitigation measures and probability of detecting fin whales reduce the likelihood of exposure and potential effects. Refer to Section 5.4 for additional information on mitigation effectiveness. Thus, the number of fin whale predicted to experience effects by the acoustic analysis is likely an overestimate.

AFAST sources are transient as active sonar activities pass through an area. Although these marine mammals may exhibit a reaction when exposed to sound from AFAST active sonar activities, the exposures are not expected to be long-term due to the relatively short duration of potential exposures.

The Navy evaluated potential exposures to stocks based on the best estimate for each stock of marine mammal species, as published in the stock assessment reports by NMFS. Fin whales are currently considered as a single stock in the western North Atlantic. The best abundance estimate for the Western North Atlantic stock of fin whales is 2,269 (Waring et al., 2008). Waring et al. (2008) notes that the population is likely to be larger than the best estimate because the habitat of the stock is not well known, and there are uncertainties with regard to population structure, and movements of whales between surveyed and unsurveyed areas. Fin whales are not expected to occur in the Gulf of Mexico.

Based on best available science, the Navy concludes that exposures to fin whales due to AFAST active sonar activities would generally result in only short-term effects to individuals exposed and would likely not affect annual rates of recruitment or survival. The mitigations presented in Chapter 5 will further reduce the potential for exposures to occur to fin whales.

In accordance with NEPA, there will be no significant impact to fin whales from AFAST active sonar activities in territorial waters under the No Action Alternative, Alternative 1, Alternative 2, or Alternative 3. Further, in accordance with EO 12114, there will be no significant harm to fin whales from AFAST active sonar activities in non-territorial waters under the No Action Alternative, Alternative 1, Alternative 2, or Alternative 3.

In accordance with the ESA, the Navy finds that AFAST active sonar activities may affect fin whales. The Navy initiated consultation with NMFS in accordance with Section 7 of the ESA for concurrence.

4.4.10.3.5 Blue Whale

Acoustic analysis is not available for blue whales due to the lack of abundance and density data for North Atlantic populations. Population estimates are available only for the Gulf of St. Lawrence area (off eastern Canada), where 308 individuals have been catalogued (Waring et al., 2002). This number is considered to be the minimum population estimate for the western North Atlantic stock. The entire population may total only in the hundreds, but no conclusive data exist to confirm or refute this estimate (Waring et al., 2002).

Blue whales occur primarily in deep offshore water, with occasional sightings on the continental shelf. This species is considered to occur only occasionally in the U.S. EEZ, and the northeastern EEZ may represent the southern limit of blue whale feeding grounds. There are a few records of blue whale occurrence in the Atlantic OPAREAs, and only two reliable records in the GOMEX.

An undetermined number of blue whales could be exposed to sound levels likely to result in Level B harassment. Based on the presumed relatively small population and low number of recorded sightings in the OPAREAs, the number of potential exposures is probably low. No exposure of individuals to sound levels likely to result in Level A harassment is expected. No mortality due to explosive sonobuoys is expected. Lookouts would likely detect blue whales at the surface due to their large size and large vertical blow of up to 9 m (30 ft) (Wynn and Schwartz, 1999). Implementation of mitigation measures and probability of detecting a large blue whale reduce the likelihood of exposure and potential effects. Refer to Section 5.4 for additional information on mitigation effectiveness.

Blue whales belong to the low-frequency functional hearing group. Because the acoustic analysis does not consider the specific hearing frequency range of the blue whale, the numbers of predicted physiological and behavioral effects are likely to be an overestimate.

AFAST sources are transient as active sonar activities pass through an area. Although these marine mammals may exhibit a reaction when exposed to sound from AFAST active sonar activities, the exposures are not expected to be long-term due to the relatively short duration of potential exposures.

Based on best available science, the Navy concludes that exposures to blue whales due to AFAST active sonar activities would generally result in short-term effects to individuals exposed and would likely not affect annual rates of recruitment or survival. The mitigations presented in Chapter 5 will further reduce the potential for exposures to occur to blue whales.

In accordance with NEPA, there will be no significant impact to blue whales from AFAST active sonar activities in territorial waters under the No Action Alternative, Alternative 1, Alternative 2, or Alternative 3. Further, in accordance with EO 12114, there will be no significant harm to blue whales from AFAST active sonar activities in non-territorial waters under the No Action Alternative, Alternative 1, Alternative 2, or Alternative 3.

In accordance with the ESA, the Navy finds that AFAST active sonar activities may affect blue whales. The Navy initiated consultation with NMFS in accordance with Section 7 of the ESA for concurrence.

4.4.10.3.6 Sperm Whale

Acoustic analysis indicates that up to 9,757 sperm whales may be exposed to levels of sound likely to result in Level B harassment under the No Action Alternative, 6,076 under Alternative 1, 5, 371 under Alternative 2, and 8,374 under Alternative 3. The exposure estimates for each alternative represents the total number of exposures and not necessarily the number of individuals exposed, as a single individual may be exposed multiple times over the course of a year. Acoustic analysis indicates that up to one sperm whale may be exposed to levels of sound likely to result in Level A harassment under the No Action Alternative, and zero under Alternative 1, Alternative 2, or Alternative 3. Modeling of the explosive source sonobuoys (AN/SSQ-110A) predicts no potential for mortality to sperm whales.

Sperm whales belong to the mid-frequency cetacean group. No direct tests on sperm whale hearing have been made, although the anatomy of the sperm whale's inner and middle ear indicates an ability to best hear high frequency sounds. Behavioral observations have been made whereby during playback experiments off the Canary Islands, André et al. (1997) reported that foraging whales exposed to a 10-kHz pulsed signal did not exhibit any general avoidance reactions. When resting at the surface in a compact group, sperm whales initially reacted strongly, and then ignored the signal completely (André et al., 1997).

Lookouts would likely detect a group of sperm whales at the surface given their large size (up to 17 m [56 ft]) (Leatherwood and Reeves, 1982), pronounced blow (large and angled), and group size (between 10 to 80 for females and young) (Wynn and Schwartz, 1999). However, as a deep diving species, sperm whales can stay submerged, and therefore visually undetectable for over an hour. Refer to Section 5.4 for additional information on mitigation effectiveness.

AFAST sources are transient as active sonar activities pass through an area. Although these marine mammals may exhibit a reaction when exposed to sound from AFAST active sonar activities, the exposures are not expected to be long-term due to the relatively short duration of potential exposures.

The Navy evaluated potential exposures to stocks based on the best estimate for each stock of marine mammal species, as published in the stock assessment reports by NMFS. Sperm whales are currently considered as a single stock in the western North Atlantic. NMFS provisionally considers the sperm whale population in the northern GOMEX, the Gulf of Mexico stock, distinct from the U.S. Atlantic stock (Waring et al., 2006). Genetic analyses, coda vocalizations, and population structure support this (Jochens et al., 2006). Stock structure for sperm whales in the North Atlantic is not known (Dufault et al., 1999). The best abundance estimate for sperm whales for the western North Atlantic is 4,804 (Waring et al., 2007). The current best abundance estimate for sperm whales in the northern GOMEX is 1,665 individuals (Waring et al., 2008).

Based on best available science, the Navy concludes that exposures to sperm whales due to AFAST active sonar activities would generally result in only short-term effects to individuals exposed and would likely not affect annual rates of recruitment or survival. The mitigations presented in Chapter 5 will further reduce the potential for exposures to occur to sperm whales.

In accordance with NEPA, there will be no significant impact to sperm whales *from AFAST active sonar activities in territorial waters under the No Action Alternative, Alternative 1, Alternative 2, or Alternative 3*. Further, in accordance with EO 12114, there will be no significant harm to sperm whales from AFAST active sonar activities in non-territorial waters under the No Action Alternative, Alternative 1, Alternative 2, or Alternative 3.

In accordance with the ESA, the Navy finds that AFAST active sonar activities may affect sperm whales. The Navy initiated consultation with NMFS in accordance with Section 7 of the ESA for concurrence.

4.4.10.3.7 Manatee

With the exception of maintenance and ship object detection/navigational sonar training, no AFAST active sonar activity would be conducted within Florida manatee habitat under any of the alternatives. The manatee is considered to be an inshore species, with most sightings occurring in warm freshwater, estuarine, and extremely nearshore coastal waters. During winter, manatees are largely restricted to peninsular Florida in the Gulf of Mexico and to Florida and southeastern Georgia in the Atlantic Ocean. Distribution expands northward and eastward in warmer months. Exposure numbers for the manatees occurring in the southeast could not be calculated due to the lack of acoustic exposure criteria and lack of available density information.

Southall et al. (2007) does not assign manatees to any functional group. Behavioral data on two animals indicate an underwater hearing range of approximately 0.4 to 46 kHz, with best sensitivity between 16 and 18 kHz (Gerstein et al., 1999), while earlier electrophysiological studies indicated best sensitivity from 1 to 1.5 kHz (Bullock et al., 1982). Therefore, it appears that manatees have the capability of hearing active sonar. In one study, manatees were shown to react to the sound from approaching or passing boats by moving into deeper waters or increasing swimming speed (Nowacek et al., 2004). By extension, manatees could react to active sonar;

however, there is no evidence to suggest the reaction would likely disturb the manatee to a point where their behaviors are abandoned or significantly altered. Specifically, manatees did not respond to sounds with frequency ranges of 10 to 80 kHz produced by a pinger every 4 seconds for 300 milliseconds (Bowles et al., 2001). The pings' energy was predominantly in the 10 to 40 kHz range (the mid to high portion of manatee hearing). The source level of the sound was approximately 130 dB re 1 μPa-m.

Additionally, Hubbs-SeaWorld Research Institute (HSWRI) initially tested a manatee detection device based on sonar (Bowles, et al., 2004). In addition to conducting sonar reflectivity, the experiments also included a behavioral response study. Experiments were conducted with 10 kHz pings, whereby the sound level was increased by 10 dB from 130 dB to 180 dB or until the researchers observed distress. Rapid swimming, thrashing of the body or paddle, and spinning while swimming indicated distress. Researchers found that manatees detected the 10 kHz pings and approached the transducer cage when the sonar was turned on initially. However, none of the responses indicated that the manatees responded with intense avoidance or distress. The authors concluded that manatees do not exhibit strong startle responses or an aggressive nature towards acoustic stimuli, which differs from experiments conducted on cetaceans and pinnipeds (Bowles, et al., 2004). Thus, based on the best available science, it is possible that manatees would hear mid- and high-frequency sonar, but would not likely show a strong reaction or be disturbed from their normal range of behaviors.

AFAST sources are transient as active sonar activities pass through an area. Although these marine mammals may exhibit a reaction when exposed to sound from AFAST active sonar activities, the exposures are not expected to be long-term due to the relatively short duration of potential exposures.

Based on best available science, the limited active sonar activities that could occur within Florida manatee habitat (i.e., maintenance and ship object detection/navigational sonar training), and the available information on manatee hearing, the Navy concludes that exposures to manatees due to AFAST active sonar activities would likely not affect annual rates of recruitment or survival. The mitigations presented in Chapter 5 will further reduce the potential for exposures to occur to manatees.

Therefore, in accordance with NEPA, there will be no significant impact to manatees from AFAST active sonar activities in territorial waters under the No Action Alternative, Alternative 1, Alternative 2, or Alternative 3.

In accordance with the ESA, the Navy finds that AFAST active sonar activities will have no effect on manatees.

4.4.10.4 Estimated Exposures for Non-ESA-Listed Species

For the purposes of this section, "active sonar activities" refers to training, maintenance, and RDT&E activities involving mid- and high-frequency active sonar and the explosive source sonobuoy (AN/SSQ-110A).

4.4.10.4.1 Minke Whale

Acoustic analysis indicates that up to 415 minke whales may be exposed to levels of sound likely to result in Level B harassment under the No Action Alternative, 221 under Alternative 1, 213 under Alternative 2, and 478 under Alternative 3. The exposure estimates for each alternative represents the total number of exposures and not necessarily the number of individuals exposed, as a single individual may be exposed multiple times over the course of a year. Acoustic analysis indicates that no minke whales will be exposed to sound levels likely to result in Level A harassment. Modeling of the explosive source sonobuoys (AN/SSQ-110A) predicts no potential for mortality to minke whales.

Minke whales belong to the low-frequency cetacean functional hearing group. There are no tests or modeling estimates of specific minke whale hearing ranges. Because the acoustic analysis does not consider the specific hearing frequency range of the minke whale, the numbers of predicted physiological and behavioral effects are likely to be an overestimate.

Due to the conspicuousness of this species at the surface, lookouts would likely detect a group of minke whales given their large size (up to 8 m [27 ft]), pronounced blow, breaching behavior, and tendency to approach vessels (Wynn and Schwartz, 1999; Barlow, 2005). Implementation of mitigation measures and probability of detecting large minke whales reduce the likelihood of exposure and potential effects. Refer to Section 5.4 for additional information on mitigation effectiveness. Thus, the number of minke whales predicted to experience effects by the acoustic analysis is likely an overestimate.

AFAST sources are transient as active sonar activities pass through an area. Although these marine mammals may exhibit a reaction when exposed to sound from AFAST active sonar activities, the exposures are not expected to be long-term due to the relatively short duration of potential exposures.

The Navy evaluated potential exposures to stocks based on the best estimate for each stock of marine mammal species, as published in the stock assessment reports by NMFS. There are four recognized populations in the North Atlantic Ocean: Canadian East Coast, West Greenland, Central North Atlantic, and Northeastern North Atlantic (Donovan, 1991; Waring et al., 2007). Minke whales off the eastern United States are considered to be part of the Canadian East Coast stock which inhabits the area from the eastern half of the Davis Strait to 45ºW and south to the Gulf of Mexico (Waring et al., 2007). The best available abundance estimate for minke whales from the Canadian East Coast stock is 3,312 animals (Waring et al., 2008). The minke whale is not expected in the Gulf of Mexico.

Based on best available science, the Navy concludes that exposures to minke whales due to AFAST active sonar activities would generally result in only short-term effects to individuals exposed and would likely not affect annual rates of recruitment or survival. The mitigations presented in Chapter 5 will further reduce the potential for exposures to occur to minke whales.

In accordance with NEPA, there will be no significant impact to minke whales *from AFAST active sonar activities in territorial waters under the No Action Alternative, Alternative 1, Alternative 2, or Alternative 3*. Further, in accordance with EO 12114, there will be no significant harm to minke whales from AFAST active sonar activities in non-territorial waters under the No Action Alternative, Alternative 1, Alternative 2, or Alternative 3. The Navy initiated consultation with NMFS in accordance with the MMPA.

4.4.10.4.2 Bryde's Whale

Acoustic analysis indicates that up to 26 Bryde's whales may be exposed to levels of sound likely to result in Level B harassment under the No Action Alternative, 25 under Alternative 1, three under Alternative 2, and 25 under Alternative 3. The exposure estimates for each alternative represents the total number of exposures and not necessarily the number of individuals exposed, as a single individual may be exposed multiple times over the course of a year. Acoustic analysis indicates that no Bryde's whales will be exposed to sound levels likely to result in Level A harassment. Modeling of the explosive source sonobuoys (AN/SSQ-110A) predicts no potential for mortality to Bryde's whales.

Bryde's whales belong to low-frequency cetacean functional hearing group. There are no tests or modeling estimates of specific Bryde's whale hearing ranges. Because the acoustic analysis does not consider the specific hearing frequency range of the Bryde's whale, the numbers of predicted physiological and behavioral effects are likely to be an overestimate.

Lookouts would likely detect a group of Bryde's whales at the surface given their large size (up to 14 m [46 ft]), pronounced blow, , and behavior of sometimes approaching vessels (Wynn and Schwartz, 1999). Implementation of mitigation measures and probability of detecting a Bryde's whale reduce the likelihood of exposure and potential effects. Refer to Section 5.4 for additional information on mitigation effectiveness. Thus, the number of Bryde's whales predicted to experience effects by the acoustic analysis is likely an overestimate.

AFAST sources are transient as active sonar activities pass through an area. Although these marine mammals may exhibit a reaction when exposed to sound from AFAST active sonar activities, the exposures are not expected to be long-term due to the relatively short duration of potential exposures.

The Navy evaluated potential exposures to stocks based on the best estimate for each stock of marine mammal species, as published in the stock assessment reports by NMFS. Bryde's whales are not expected in U.S. waters of the western North Atlantic. Bryde's whales are currently considered as a single, separate stock in the northern Gulf of Mexico. It has been suggested that the Bryde's whales found in the GOMEX may represent a resident stock (Schmidly, 1981), but there is no information on stock differentiation (Waring et al., 2008). The best abundance estimate for Bryde's whales within the northern Gulf of Mexico is 15 (Waring et al., 2008).

Based on best available science, the Navy concludes that exposures to Bryde's whales due to AFAST active sonar activities would generally result in only short-term effects to individuals exposed and would likely not affect annual rates of recruitment or survival. The mitigations presented in Chapter 5 will further reduce the potential for exposures to occur to Bryde's whales.

In accordance with NEPA, there will be no significant impact to Bryde's whales from AFAST active sonar activities in territorial waters under the No Action Alternative, Alternative 1, *Alternative 2, or Alternative 3*. Further, in accordance with EO 12114, there will be no significant harm to Bryde's whales from AFAST active sonar activities in non-territorial waters under the No Action Alternative, Alternative 1, Alternative 2, or Alternative 3. The Navy initiated consultation with NMFS in accordance with the MMPA.

4.4.10.4.3 Pygmy and Dwarf Sperm Whales

Acoustic analysis indicates that up to 4,386 pygmy and dwarf sperm whales may be exposed to levels of sound likely to result in Level B harassment under the No Action Alternative, 4,373 under Alternative 1, 3,871 under Alternative 2, and 4,424 under Alternative 3. The exposure estimates for each alternative represents the total number of exposures and not necessarily the number of individuals exposed, as a single individual may be exposed multiple times over the course of a year. Acoustic analysis indicates that no pygmy or dwarf sperm whales will be exposed to sound levels likely to result in Level A harassment. Modeling of the explosive source sonobuoys (AN/SSQ-110A) predicts no potential for mortality to pygmy or dwarf sperm whales.

Pygmy and dwarf sperm whales belong to the high-frequency cetacean functional hearing group. There are no tests or modeling estimates of specific pygmy and dwarf sperm whale hearing ranges.

Lookouts may not readily sight pygmy and dwarf sperm whales because these species are cryptic (difficult to detect at the surface), deep diving, and have a "low and inconspicuous" blow (Wynn and Schwartz, 1999). Refer to Section 5.4 for additional information on mitigation effectiveness.

AFAST sources are transient as active sonar activities pass through an area. Although these marine mammals may exhibit a reaction when exposed to sound from AFAST active sonar activities, the exposures are not expected to be long-term due to the relatively short duration of potential exposures.

The Navy evaluated potential exposures to stocks based on the best estimates presented in the stock assessment reports published by NMFS. There is currently no information to differentiate Atlantic stock(s) (Waring et al., 2007). The best abundance estimate for both species combined in the western North Atlantic is 395 individuals (Waring et al., 2007). Species-level abundance estimates cannot be calculated due to uncertainty of species identification at sea (Waring et al., 2007). There is currently no information to differentiate the Northern GOMEX stock from the Atlantic stock(s) (Waring et al., 2008). For pygmy and dwarf sperm whales in the Northern Gulf of Mexico, the best abundance estimate is 453 animals (Waring et al., 2008). A separate abundance estimate for the pygmy sperm whale or the dwarf sperm whale cannot be calculated due to uncertainty of species identification at sea (Waring et al., 2008).

Based on best available science, the Navy concludes that exposures to pygmy and dwarf sperm whales due to AFAST active sonar activities would generally result in only short-term effects to individuals exposed and would likely not affect annual rates of recruitment or survival.

In accordance with NEPA, there will be no significant impact to pygmy and dwarf sperm whales from AFAST active sonar activities in territorial waters under the No Action Alternative, Alternative 1, Alternative 2, or Alternative 3. Further, in accordance with EO 12114, there will be no significant harm to pygmy and dwarf sperm whales from AFAST active sonar activities in non-territorial waters under the No Action Alternative, Alternative 1, Alternative 2, or Alternative 3. The Navy initiated consultation with NMFS in accordance with the MMPA.

4.4.10.4.4 Beaked Whales (various species)

Acoustic analysis indicates that up to 4,909 beaked whales may be exposed to levels of sound likely to result in Level B harassment under the No Action Alternative, 2,114 under Alternative 1, 1,725 under Alternative 2, and 3,435 under Alternative 3. The exposure estimates for each alternative represents the total number of exposures and not necessarily the number of individuals exposed, as a single individual may be exposed multiple times over the course of a year. Acoustic analysis indicates that no beaked whales will be exposed to sound levels likely to result in Level A harassment. Modeling of the explosive source sonobuoys (AN/SSQ-110A) predicts no potential for mortality to beaked whales.

Beaked whales belong to the mid-frequency cetacean functional hearing group. However, due to their physiology, they may be more sensitive than other cetaceans to low-frequency sounds as well (MacLeod, 1999; Ketten, 2000). The only direct measure of beaked whale hearing is from a stranded juvenile Gervais' beaked whale using auditory evoked potential techniques (Cook et al., 2006). The hearing frequency range was 5 to 80 kHz, with greatest sensitivity at 40 and 80 kHz (Cook et al., 2006). Some have proposed a potential association between beaked whale strandings and Navy activities, noting five recurring factors in common with each stranding event: use of mid-frequency sonar, beaked whale presence, surface ducts, steep bathymetry, and constricted channels with limited egress. These five factors would not occur simultaneously within the AFAST Study Area.

Most beaked whale species are difficult to identify to the species level at sea; therefore, much of the available characterization for beaked whales is to genus level only *(Ziphius* and *Mesoplodon* species). Lookouts may not easily spot beaked whales. Though some beaked whale species may travel in groups of 2 to 25 individuals, beaked whales are not readily sighted due to their inconspicuous blow and apparent behavior of avoiding vessels (Wynn and Schwartz, 1999). Refer to Section 5.4 for additional information on mitigation effectiveness. Four species of *Mesoplodon* are found in the in the northwest Atlantic. These include True's beaked whale, *Mesoplodon mirus*; Gervais' beaked whale, *M. europaeus*; Blainville's beaked whale, *M. densirostris*; and Sowerby's beaked whale, *M. bidens*. Stock structure for each species is unknown (Waring et al., 2004).

The best abundance estimate for Cuvier's beaked whales in the northern Gulf of Mexico is 65 individuals (Waring et al., 2008). The total number of Cuvier's beaked whales off the eastern U.S. and Canadian Atlantic coast is unknown, but there have been several estimates of an undifferentiated grouping of beaked whales that includes both *Ziphius* and *Mesoplodon* species. The best abundance estimate for undifferentiated beaked whales (*Ziphius* and *Mesoplodon* species) in the Western North Atlantic is 3,513 (Waring et al., 2008). It is not possible to determine the minimum population estimate of only Cuvier's beaked whales.

Identification of *Mesoplodon* to species in the Gulf of Mexico is very difficult, and in many cases, *Mesoplodon* and Cuvier's beaked whale (*Ziphius cavirostris*) cannot be distinguished;

therefore, sightings of beaked whales (Family Ziphiidae) are identified as *Mesoplodon* sp., Cuvier's beaked whale, or unidentified Ziphiidae. The best abundance estimate for *Mesoplodon* species in the northern Gulf of Mexico is 57 animals (Waring et al., 2008). Present data are insufficient to calculate minimum population estimates for all *Mesoplodon* species in the western North Atlantic. The total number of northern bottlenose whales off the East Coast is unknown.
AFAST sources are transient as active sonar activities pass through an area. Although these marine mammals may exhibit a reaction when exposed to sound from AFAST active sonar activities, the exposures are not expected to be long-term due to the relatively short duration of potential exposures.

In general, the Navy evaluated potential exposures to stocks based on the best estimate for each stock of marine mammal species, as published in the SAR by NMFS. Because many beaked whales are difficult to differentiate at sea, density estimates are only available for beaked whales as a group. It is possible to make some broad inferences about effects to individual species based on their generally accepted abundance estimates in each region but it is important to keep in mind the difficulty in identifying most individuals beyond the genus level.

Based on the best available science, the Navy concludes that exposures to beaked whales due to AFAST active sonar activities would generally result in only short-term effects to individuals exposed and would likely not affect annual rates of recruitment or survival. However, because of a lack of scientific consensus regarding the causal link between sonar and stranding events, NMFS has stated in a letter to the Navy dated October 2006 that it "cannot conclude with certainty the degree to which mitigation measures would eliminate or reduce the potential for serious injury of mortality".

Therefore, the Navy is requesting 10 serious injury or mortality takes for beaked whale species. This approach overestimates the potential effects to marine mammals associated with Navy sonar training in the AFAST Study Area, as no mortality or serious injury of any species is anticipated. This request will be made even though almost 40 years of conducting similar exercises without incident in the operating environments represented in the AFAST Study Area indicate that injury, strandings, and mortality are not expected to occur as a result of Navy activities.

Neither NMFS nor the Navy anticipates that marine mammal strandings or mortality will result from the operation of mid- or high frequency sonar during Navy exercises within the AFAST Study Area. Additionally, through the MMPA process (which allows for adaptive management), NMFS and the Navy will determine the appropriate way to proceed in the event that a causal relationship were to be found between Navy activities and a future stranding.

In accordance with NEPA, there will be no significant impact to beaked whales from AFAST active sonar activities in territorial waters under the No Action Alternative, Alternative 1, Alternative 2, or Alternative 3. Further, in accordance with EO 12114, there will be no significant harm to beaked whales from AFAST active sonar activities in non-territorial waters under the No Action Alternative, Alternative 1, Alternative 2, or Alternative 3. The Navy initiated consultation with NMFS in accordance with the MMPA.

4.4.10.4.5 Rough-Toothed Dolphin

Acoustic analysis indicates that up to 2,709 rough-toothed dolphins may be exposed to levels of sound likely to result in Level B harassment under the No Action Alternative, 2,709 under Alternative 1, 1,940 under Alternative 2, and 2,164 under Alternative 3. The exposure estimates for each alternative represents the total number of exposures and not necessarily the number of individuals exposed, as a single individual may be exposed multiple times over the course of a year. Acoustic analysis indicates that no rough-toothed dolphins will be exposed to sound levels likely to result in Level A harassment. Modeling of the explosive source sonobuoys (AN/SSQ-110A) predicts no potential for mortality to rough-toothed dolphins.

Rough-toothed dolphins belong to the mid-frequency cetacean functional hearing group. Scientists have determined the rough-toothed dolphin can detect sounds between 5 and 80 kHz and probably much higher (Cook et al., 2005). The echolocation frequency range of this species is 0.1 to 200 kHz (Miyazaki and Perrin, 1994; Yu et al., 2003; Chou, 2005) which suggests that they are capable of hearing all AFAST sources.

Lookouts would likely detect a group of rough-toothed dolphins at the surface given their frequent surfacing and mean group sizes ranging from tens to hundreds (Wynn and Schwartz, 1999). Implementation of mitigation measures and probability of detecting a rough-toothed dolphin reduce the likelihood of exposure and potential effects. Refer to Section 5.4 for additional information on mitigation effectiveness. Thus, the number of rough-toothed dolphins predicted to experience effects by the acoustic analysis is likely an overestimate.

AFAST sources are transient as active sonar activities pass through an area. Although these marine mammals may exhibit a reaction when exposed to sound from AFAST active sonar activities, the exposures are not expected to be long-term due to the relatively short duration of potential exposures.

The Navy evaluated potential exposures to stocks based on the best estimates presented in the stock assessment reports published by NMFS. There is no information on stock differentiation for the western North Atlantic stock of this species and no abundance estimates are available for rough-toothed dolphins here. The best abundance estimate for rough-toothed dolphins is 2,653 in the northern Gulf of Mexico (Waring et al., 2008).

Based on best available science, the Navy concludes that exposures to rough-toothed dolphins due to AFAST active sonar activities would generally result in only short-term effects to individuals exposed and would likely not affect annual rates of recruitment or survival. The mitigations presented in Chapter 5 will further reduce the potential for exposures to occur to rough-toothed dolphins.

In accordance with NEPA, there will be no significant impact to rough-toothed dolphins from AFAST active sonar activities in territorial waters under the No Action Alternative, Alternative 1, Alternative 2, or Alternative 3. Further, in accordance with EO 12114, there will be no significant harm to rough-toothed dolphins from AFAST active sonar activities in non-territorial waters under the No Action Alternative, Alternative 1, Alternative 2, or Alternative 3. The Navy initiated consultation with NMFS in accordance with the MMPA.

4.4.10.4.6 Bottlenose Dolphin

Acoustic analysis indicates that up to 606,803 bottlenose dolphins may be exposed to levels of sound likely to result in Level B harassment under the No Action Alternative, 337,967 under Alternative 1, 360,729 under Alternative 2, and 524,836 under Alternative 3. The exposure estimates for each alternative represents the total number of exposures and not necessarily the number of individuals exposed, as a single individual may be exposed multiple times over the course of a year. Acoustic analysis indicates that up to 47 bottlenose dolphins may be exposed to levels of sound likely to result in Level A harassment under the No Action Alternative, 26 under Alternative 1, 28 under Alternative 2, and 42 under Alternative 3. Modeling of the explosive source sonobuoys (AN/SSQ-110A) predicts no potential for mortality to bottlenose dolphins.

Bottlenose dolphins belong to the mid-frequency cetacean functional hearing group with peaks in sensitivity at 25 and 50 kHz (Nachtigall et al., 2000). This species is likely to hear all sources used during AFAST active sonar activities.

Bottlenose dolphins tend to have relatively short dives; given their frequent surfacing and offshore groups sizes ranging from tens to hundreds (Wynn and Schwartz, 1999), lookouts would be more likely detect a group of bottlenose dolphins at the surface. Implementation of mitigation measures and probability of detecting a bottlenose dolphin reduce the likelihood of exposure and potential effects. Refer to Section 5.4 for additional information on mitigation effectiveness. Thus, the number of bottlenose dolphins predicted to experience effects by the acoustic analysis is likely an overestimate.

AFAST sources are transient as active sonar activities pass through an area. Although these marine mammals may exhibit a reaction when exposed to sound from AFAST active sonar activities, the exposures are not expected to be long-term due to the relatively short duration of potential exposures.

The Navy considered potential effects to stocks based on the best available data for each stock of marine mammal species. A number of stocks exist for the bottlenose dolphin in the western North Atlantic and the northern Gulf of Mexico. Therefore, the assessment focuses on the stocks that occur within the area for AFAST active sonar activities that have the potential to overlap the species' distributions.

For the western North Atlantic, estimates of this species include both the coastal and offshore stocks. The best estimate for the western North Atlantic coastal stock of bottlenose dolphins is 15,620 and the best estimate for the western North Atlantic offshore stock of bottlenose dolphins is 81,588 (Waring et al., 2008). Torres et al. (2003) found a statistically significant break in the distribution of the morphotypes at 34 km (18 NM) from shore based upon the genetic analysis of tissue samples collected in nearshore and offshore waters. The offshore morphotype was found exclusively seaward of 34 km (18 NM) and in waters deeper than 34 m (18 NM). Within 7.5 km (4 NM) of shore, all animals were of the coastal morphotype. More recently, offshore morphotype animals have been sampled as close as 7.3 km (4 NM) from shore in water depths of 13 m (43 ft) (Garrison et al., 2003). Due to the apparent mixing of the coastal and offshore stocks of bottlenose dolphins along the Atlantic coast it is impossible to estimate the percentage of each stock potentially exposed to sonar from AFAST. The general distribution of AFAST training activities suggests that the majority of estimated exposures to bottlenose dolphins will be to the offshore stock, however some small proportion of exposures will likely apply to the coastal stocks as well.

In the northern GOMEX, the stocks of concern include the continental shelf and oceanic stocks. The continental shelf stock is thought to overlap with both the oceanic stock as well as coastal stocks in some areas (Waring et al., 2008); however, the coastal stock is generally limited to less than 20 m (66 ft) water depths and therefore is not expected to be exposed to sonar from AFAST. The best abundance estimate for the continental shelf stock is 21,531 (Waring et al., 2008). The estimated abundance for bottlenose dolphins in oceanic waters is 3,708 (Waring et al., 2008). The oceanic stock is provisionally defined for bottlenose dolphins inhabiting waters greater than 200 m (656 ft) (Waring et al., 2008). While the two stocks may overlap to some degree the Navy estimates, based on the distribution of AFAST active sonar activities, that most of the predicted exposures will occur to the oceanic stock with the few remaining exposures applying to the continental stock.

Based on best available science, the Navy concludes that exposures to bottlenose dolphins due to AFAST active sonar activities would generally result in only short-term effects to individuals exposed and would likely not affect annual rates of recruitment or survival. The mitigations presented in Chapter 5 will further reduce the potential for exposures to occur to bottlenose dolphins.

In accordance with NEPA, there will be no significant impact to bottlenose dolphins from AFAST active sonar activities in territorial waters under the No Action Alternative, Alternative 1, Alternative 2, or Alternative 3. Further, in accordance with EO 12114, there will be no significant harm to bottlenose dolphins from AFAST active sonar activities in non-territorial waters under the No Action Alternative, Alternative 1, Alternative 2, or Alternative 3. The Navy initiated consultation with NMFS in accordance with the MMPA.

4.4.10.4.7 Pantropical Spotted Dolphins

Acoustic analysis indicates that up to 139,305 pantropical spotted dolphins may be exposed to levels of sound likely to result in Level B harassment under the No Action Alternative, 141,422 under Alternative 1, 87,512 under Alternative 2, and 134,282 under Alternative 3. The exposure estimates for each alternative represents the total number of exposures and not necessarily the number of individuals exposed, as a single individual may be exposed multiple times over the course of a year. Acoustic analysis indicates that up to 12 pantropical spotted dolphins may be exposed to levels of sound likely to result in Level A harassment under the No Action Alternative, 13 under Alternative 1, seven under Alternative 2, and 12 under Alternative 3. Modeling of the explosive source sonobuoys (AN/SSQ-110A) predicts no potential for mortality to pantropical spotted dolphins.

Pantropical spotted dolphins belong to the mid-frequency cetacean functional hearing group. This species is likely to hear all sources used during AFAST active sonar activities.

Given their frequent surfacing, large group sizes that can exceed 1,000 individuals and a tendency to bowride vessels (Wynn and Schwartz, 1999), lookouts would likely detect a group of pantropical spotted dolphins at the surface. Implementation of mitigation measures and probability of detecting large groups of pantropical spotted dolphins reduce the likelihood of exposure. Refer to Section 5.4 for additional information on mitigation effectiveness. Thus, the number of pantropical spotted dolphins predicted to experience effects by the acoustic analysis is likely an overestimate.

AFAST sources are transient as active sonar activities pass through an area. Although these marine mammals may exhibit a reaction when exposed to sound from AFAST active sonar activities, the exposures are not expected to be long-term due to the relatively short duration of potential exposures.

In general, the Navy evaluated potential exposures to stocks based on the best estimate for each stock of marine mammal species, as published in the stock assessment report by NMFS. In the western North Atlantic, the best abundance estimate for pantropical spotted dolphins is 4,439 (Waring et al., 2008). The best abundance estimate for pantropical spotted dolphins in the northern Gulf of Mexico is 34,067 (Waring et al., 2008).

Based on best available science, the Navy concludes that exposures to pantropical spotted dolphins due to AFAST active sonar activities would generally result in only short-term effects to individuals exposed and would likely not affect annual rates of recruitment or survival. The mitigations presented in Chapter 5 will further reduce the potential for exposures to occur to pantropical spotted dolphins.

In accordance with NEPA, there will be no significant impact to pantropical spotted dolphins from AFAST active sonar activities in territorial waters under the No Action Alternative, Alternative 1, Alternative 2, or Alternative 3. Further, in accordance with EO 12114, there will be no significant harm to pantropical spotted dolphins from AFAST active sonar activities in non-territorial waters under the No Action Alternative, Alternative 1, Alternative 2, or Alternative 3. The Navy initiated consultation with NMFS in accordance with the MMPA.

4.4.10.4.8 Atlantic Spotted Dolphin

Acoustic analysis indicates that up to 376,362 Atlantic spotted dolphins may be exposed to levels of sound likely to result in Level B harassment under the No Action Alternative, 255,2550 under Alternative 1, 258,304 under Alternative 2, and 341,921 under Alternative 3. The exposure estimates for each alternative represents the total number of exposures and not necessarily the number of individuals exposed, as a single individual may be exposed multiple times over the course of a year. Acoustic analysis indicates that up to 27 Atlantic spotted dolphins may be exposed to levels of sound likely to result in Level A harassment under the No Action Alternative, 20 under Alternative 1, 19 under Alternative 2, and 23 under Alternative 3. Modeling of the explosive source sonobuoys (AN/SSQ-110A) predicts no potential for mortality to Atlantic spotted dolphins.

Atlantic spotted dolphins belong to the mid-frequency cetacean functional hearing group. This species is likely to hear all sources used during AFAST active sonar activities.

Lookouts would likely detect a group of Atlantic spotted dolphins at the surface given their frequent surfacing and large group size encompassing hundreds of animals (Leatherwood and Reeves, 1982; Wynn and Schwartz, 1999). Implementation of mitigation measures and probability of detecting large groups of Atlantic spotted dolphins reduce the likelihood of exposure. Refer to Section 5.4 for additional information on mitigation effectiveness. Thus, the number of Atlantic spotted dolphins predicted to experience effects by the acoustic analysis is likely an overestimate.

AFAST sources are transient as active sonar activities pass through an area. Although these marine mammals may exhibit a reaction when exposed to sound from AFAST active sonar activities, the exposures are not expected to be long-term due to the relatively short duration of potential exposures.

In general, the Navy evaluated potential exposures to stocks based on the best estimate for each stock of marine mammal species, as published in the SAR by NMFS. In the North Atlantic, the best abundance estimate for Atlantic spotted dolphins is 50,978 (Waring et al., 2007). The best abundance estimate for Atlantic spotted dolphins in the northern Gulf of Mexico is 37,611 (Waring et al., 2008).

Based on best available science, the Navy concludes that exposures to Atlantic spotted dolphins due to AFAST active sonar activities would generally result in only short-term effects to individuals exposed and would likely not affect annual rates of recruitment or survival. The mitigations presented in Chapter 5 will further reduce the potential for exposures to occur to Atlantic spotted dolphins.

In accordance with NEPA, there will be no significant impact to Atlantic spotted dolphins from AFAST active sonar activities in territorial waters under the No Action Alternative, Alternative 1, Alternative 2, or Alternative 3. Further, in accordance with EO 12114, there will be no significant harm to Atlantic spotted dolphins from AFAST active sonar activities in non-territorial waters under the No Action Alternative, Alternative 1, Alternative 2, or Alternative 3. The Navy initiated consultation with NMFS in accordance with the MMPA.

4.4.10.4.9 Spinner Dolphin

Acoustic analysis indicates that up to 20,913 spinner dolphins may be exposed to levels of sound likely to result in Level B harassment under the No Action Alternative, 10,617 under Alternative 1, 631 under Alternative 2, and 20,868 under Alternative 3. The exposure estimates for each alternative represents the total number of exposures and not necessarily the number of individuals exposed, as a single individual may be exposed multiple times over the course of a year. Acoustic analysis indicates that up to two spinner dolphins may be exposed to levels of sound likely to result in Level A harassment under the No Action Alternative, one under Alternative 1, zero under Alternative 2, and two under Alternative 3. Modeling of the explosive source sonobuoys (AN/SSQ-110A) predicts no potential for mortality to spinner dolphins.

Spinner dolphins belong to the mid-frequency cetacean functional hearing group. This species is likely to hear all sources used during AFAST active sonar activities.

Lookouts would likely detect a group of spinner dolphins at the surface given their frequent surfacing, aerobatic behavior, tendency to bowride, and group size ranging from tens to hundreds (Wynn and Schwartz, 1999). Implementation of mitigation measures and probability of detecting large groups of spinner dolphins reduce the likelihood of exposure. Refer to Section 5.4 for additional information on mitigation effectiveness. Thus, the number of spinner dolphins predicted to experience effects by the acoustic analysis is likely an overestimate.

AFAST sources are transient as active sonar activities pass through an area. Although these marine mammals may exhibit a reaction when exposed to sound from AFAST active sonar activities, the exposures are not expected to be long-term due to the relatively short duration of potential exposures.

The Navy evaluated potential exposures to stocks based on the best estimate for each stock of marine mammal species, as published in the stock assessment report by NMFS. No best estimate is currently available for the western North Atlantic stock of spinner dolphins. Stock structure in the western North Atlantic is unknown (Waring et al., 2007). The best abundance estimate for spinner dolphins in the northern Gulf of Mexico is 1,989 (Waring et al., 2008).

Based on best available science, the Navy concludes that exposures to spinner dolphins due to AFAST active sonar activities would generally result in only short-term effects to individuals exposed and would likely not affect annual rates of recruitment or survival. The mitigations presented in Chapter 5 will further reduce the potential for exposures to occur to spinner dolphins.

In accordance with NEPA, there will be no significant impact to spinner dolphins from AFAST active sonar activities in territorial waters under the No Action Alternative, Alternative 1, Alternative 2, or Alternative 3. Further, in accordance with EO 12114, there will be no significant harm to spinner dolphins from AFAST active sonar activities in non-territorial waters under the No Action Alternative, Alternative 1, Alternative 2, or Alternative 3. The Navy initiated consultation with NMFS in accordance with the MMPA.

4.4.10.4.10 Clymene Dolphin

Acoustic analysis indicates that up to 46,438 Clymene dolphins may be exposed to levels of sound likely to result in Level B harassment under the No Action Alternative, 44,480 under Alternative 1, 35,723 under Alternative 2, and 46,599 under Alternative 3. The exposure estimates for each alternative represents the total number of exposures and not necessarily the number of individuals exposed, as a single individual may be exposed multiple times over the course of a year. Acoustic analysis indicates that up to four Clymene dolphins may be exposed to levels of sound likely to result in Level A harassment under the No Action Alternative, four under Alternative 1, three under Alternative 2, and four under Alternative 3. Modeling of the explosive source sonobuoys (AN/SSQ-110A) predicts no potential for mortality to Clymene dolphins.

Clymene dolphins belong to the mid-frequency cetacean functional hearing group. This species is likely to hear all sources used during AFAST active sonar activities.

Given their gregarious and aerobatic behavior, tendency to approach vessels to bowride (Wynn and Schwartz, 1999), and potentially large group size of up to several hundred or even thousands of animals (Jefferson, 2006), it is likely that lookouts would detect a group of Clymene dolphins at the surface. Implementation of mitigation measures and probability of detecting large groups of Clymene dolphins reduce the likelihood of exposure. Refer to Section 5.4 for additional information on mitigation effectiveness. Thus, the number of Clymene dolphins predicted to experience effects by the acoustic analysis is likely an overestimate.

AFAST sources are transient as active sonar activities pass through an area. Although these marine mammals may exhibit a reaction when exposed to sound from AFAST active sonar activities, the exposures are not expected to be long-term due to the relatively short duration of potential exposures.

The Navy evaluated potential exposures to stocks based on the best estimate for each stock of marine mammal species, as published in the stock assessment reports by NMFS. Clymene dolphins are currently considered as a single stock in the western North Atlantic; the northern Gulf of Mexico population is considered a single stock as well. North Atlantic and northern Gulf of Mexico populations are considered separate stocks for management purposes although there is currently not enough information to distinguish these stocks (Waring et al., 2007). The number of Clymene dolphins off the Atlantic cost is unknown (Waring et al., 2007). The best abundance estimate of Clymene dolphins in the northern Gulf of Mexico is 6,575 (Waring et al., 2008).

Based on the best available science, the Navy concludes that exposures to Clymene dolphins due to AFAST active sonar activities would generally result in only short-term effects to individuals exposed and would likely not affect annual rates of recruitment or survival. The mitigations presented in Chapter 5 will further reduce the potential for exposures to occur to Clymene dolphins.

In accordance with NEPA, there will be no significant impact to Clymene dolphins from AFAST active sonar activities in territorial waters under the No Action Alternative, Alternative 1, Alternative 2, or Alternative 3. Further, in accordance with EO 12114, there will be no significant harm to Clymene dolphins from AFAST active sonar activities in non-territorial waters under the No Action Alternative, Alternative 1, Alternative 2, or Alternative 3. The Navy initiated consultation with NMFS in accordance with the MMPA.

4.4.10.4.11 Striped Dolphin

Acoustic analysis indicates that up to 174,724 striped dolphins may be exposed to levels of sound likely to result in Level B harassment under the No Action Alternative, 182,760 under Alternative 1, 181,185 under Alternative 2, and 119,994 under Alternative 3. The exposure estimates for each alternative represents the total number of exposures and not necessarily the number of individuals exposed, as a single individual may be exposed multiple times over the course of a year. Acoustic analysis indicates that up to ten striped dolphins may be exposed to levels of sound likely to result in Level A harassment under the No Action Alternative, three under Alternative 1, three under Alternative 2, and six under Alternative 3. Modeling of the explosive source sonobuoys (AN/SSQ-110A) predicts no potential for mortality to striped dolphins.

Striped dolphins belong to the mid-frequency cetacean functional hearing group. This species is likely to hear all sources used during AFAST active sonar activities.

Given their gregarious behavior and large group size of up to several hundred or even thousands of animals (Baird et al., 1993; Wynn and Schwartz, 1999), it is likely that lookouts would detect a group of striped dolphins at the surface. Implementation of mitigation measures and probability of detecting large groups of striped dolphins reduce the likelihood of exposure. Refer to Section 5.4 for additional information on mitigation effectiveness. Thus, the number of striped dolphins predicted to experience effects by the acoustic analysis is likely an overestimate.

AFAST sources are transient as active sonar activities pass through an area. Although these marine mammals may exhibit a reaction when exposed to sound from AFAST active sonar activities, the exposures are not expected to be long-term due to the relatively short duration of potential exposures.

The Navy evaluated potential exposures to stocks based on the best estimate for each stock of marine mammal species, as published in the stock assessment reports by NMFS. Striped dolphins are currently considered as a single stock in the western North Atlantic; the northern Gulf of Mexico population is considered a single stock as well. North Atlantic and northern Gulf of Mexico populations are considered separate stocks for management purposes although there is currently not enough information to distinguish these stocks. The best abundance estimate for striped dolphins in the western North Atlantic is 94,462 animals (Waring et al., 2007). The best abundance estimate of striped dolphins in the northern Gulf of Mexico is 3,325 (Waring et al., 2008).

Based on the best available science, the Navy concludes that exposures to striped dolphins due to AFAST active sonar activities would generally result in only short-term effects to individuals exposed and would likely not affect annual rates of recruitment or survival. The mitigations presented in Chapter 5 will further reduce the potential for exposures to occur to striped dolphins.

In accordance with NEPA, there will be no significant impact to striped dolphins from AFAST active sonar activities in territorial waters under the No Action Alternative, Alternative 1, Alternative 2, or Alternative 3. Further, in accordance with EO 12114, there will be no significant harm to striped dolphins from AFAST active sonar activities in non-territorial waters under the No Action Alternative, Alternative 1, Alternative 2, or Alternative 3. The Navy initiated consultation with NMFS in accordance with the MMPA.

4.4.10.4.12 Common Dolphin

Acoustic analysis indicates that up to 96,461 common dolphins may be exposed to levels of sound likely to result in Level B harassment under the No Action Alternative, 172,837 under Alternative 1, 165,568 under Alternative 2, and 73,900 under Alternative 3. The exposure estimates for each alternative represents the total number of exposures and not necessarily the number of individuals exposed, as a single individual may be exposed multiple times over the course of a year. Acoustic analysis indicates that up to five common dolphin may be exposed to levels of sound likely to result in Level A harassment under the No Action Alternative, eight under Alternative 1, seven under Alternative 2, and two under Alternative 3. Modeling of the explosive source sonobuoys (AN/SSQ-110A) predicts no potential for mortality to common dolphin.

Common dolphins belong to the mid-frequency cetacean functional hearing group. This species is likely to hear all sources used during AFAST active sonar activities.

Given their gregarious behavior and large group size of up to thousands of animals (Jefferson et al. 1993; Wynn and Schwartz, 1999), it is likely that lookouts would detect a group of common dolphins at the surface. Implementation of mitigation measures and probability of detecting large groups of common dolphins reduce the likelihood of exposure. Refer to Section 5.4 for additional information on mitigation effectiveness. Thus, the number of common dolphins predicted to experience effects by the acoustic analysis is likely an overestimate.

AFAST sources are transient as active sonar activities pass through an area. Although these marine mammals may exhibit a reaction when exposed to sound from AFAST active sonar activities, the exposures are not expected to be long-term due to the relatively short duration of potential exposures.

The Navy evaluated potential exposures to stocks based on the best estimate for each stock of marine mammal species, as published in the stock assessment reports by NMFS. Currently, there is no conclusive information available for western North Atlantic common dolphin stock structure (Waring et al., 2008). The best abundance estimate for common dolphins in the western North Atlantic is 120,743 animals (Waring et al., 2008).

Based on the best available science, the Navy concludes that exposures to common dolphins due to AFAST active sonar activities would generally result in only short-term effects to individuals exposed and would likely not affect annual rates of recruitment or survival. The mitigations presented in Chapter 5 will further reduce the potential for exposures to occur to common dolphins.

In accordance with NEPA, there will be no significant impact to common dolphins from AFAST active sonar activities in territorial waters under the No Action Alternative, Alternative 1, Alternative 2, or Alternative 3. Further, in accordance with EO 12114, there will be no significant harm to common dolphin from AFAST active sonar activities in non-territorial waters under the No Action Alternative, Alternative 1, Alternative 2, or Alternative 3. The Navy initiated consultation with NMFS in accordance with the MMPA.

4.4.10.4.13 Fraser's Dolphin

Acoustic analysis indicates that up to 346 Fraser's dolphins may be exposed to levels of sound likely to result in Level B harassment under the No Action Alternative, 342 under Alternative 1, 41 under Alternative 2, and 340 under Alternative 3. The exposure estimates for each alternative represents the total number of exposures and not necessarily the number of individuals exposed, as a single individual may be exposed multiple times over the course of a year. Acoustic analysis indicates that no Fraser's dolphins will be exposed to sound levels likely to result in

Level A harassment. Modeling of the explosive source sonobuoys (AN/SSQ-110A) predicts no potential for mortality to Fraser's dolphins.

Fraser's dolphin belongs to the mid-frequency cetacean functional hearing group. This species is likely to hear all sources used during AFAST active sonar activities.

Given their typical aggregations in large, fast-moving groups of up to several hundred animals (Jefferson and Leatherwood, 1994; Reeves et al., 1999b; Gannier, 2000), it is likely that lookouts would detect a group of Fraser's dolphins at the surface. Implementation of mitigation measures and probability of detecting large groups of Fraser's dolphins reduce the likelihood of exposure. Refer to Section 5.4 for additional information on mitigation effectiveness. Thus, the number of Fraser's dolphin predicted to experience effects by the acoustic analysis is likely an overestimate.

AFAST sources are transient as active sonar activities pass through an area. Although these marine mammals may exhibit a reaction when exposed to sound from AFAST active sonar activities, the exposures are not expected to be long-term due to the relatively short duration of potential exposures.

The Navy evaluated potential exposures to stocks based on the best estimate for each stock of marine mammal species, as published in the stock assessment reports by NMFS. Fraser's dolphins are currently considered as a single stock in the western North Atlantic; the northern Gulf of Mexico population is considered a single stock as well. No abundance estimate of Fraser's dolphins in the western North Atlantic is available (Waring et al., 2008). The best abundance estimate of Fraser's dolphins in the northern Gulf of Mexico is currently unknown, though previous estimated at 726 (Waring et al., 2006; 2008).

Based on the best available science, the Navy concludes that exposures to Fraser's dolphins due to AFAST active sonar activities would generally result in only short-term effects to individuals exposed and would likely not affect annual rates of recruitment or survival. The mitigations presented in Chapter 5 will further reduce the potential for exposures to occur to Fraser's dolphins.

In accordance with NEPA, there will be no significant impact to Fraser's dolphins from AFAST active sonar activities in territorial waters under the No Action Alternative, Alternative 1, Alternative 2, or Alternative 3. Further, in accordance with EO 12114, there will be no significant harm to Fraser's dolphins from AFAST active sonar activities in non-territorial waters under the No Action Alternative, Alternative 1, Alternative 2, or Alternative 3. The Navy initiated consultation with NMFS in accordance with the MMPA.

4.4.10.4.14 Risso's Dolphin

Acoustic analysis indicates that up to 94,074 Risso's dolphins may be exposed to levels of sound likely to result in Level B harassment under the No Action Alternative, 65,317 under Alternative 1, 76,402 under Alternative 2, and 92,639 under Alternative 3. The exposure estimates for each alternative represents the total number of exposures and not necessarily the number of individuals exposed, as a single individual may be exposed multiple times over the course of a year. Acoustic analysis indicates that up to seven Risso's dolphins may be exposed to levels of sound likely to result in Level A harassment under the No Action Alternative, five under Alternative 1, six under Alternative 2, and seven under Alternative 3. Modeling of the explosive source sonobuoys (AN/SSQ-110A) predicts no potential for mortality to Risso's dolphins.

Risso's dolphin belongs to the mid-frequency cetacean functional hearing group. This species is likely to hear all sources used during AFAST active sonar activities.

Given their frequent surfacing and large group size of up to several hundred animals (Leatherwood and Reeves, 1982; Wynn and Schwartz, 1999), it is likely that lookouts would detect a group of Risso's dolphins at the surface. Implementation of mitigation measures and probability of detecting large groups of Risso's dolphins reduce the likelihood of exposure. Refer to Section 5.4 for additional information on mitigation effectiveness. Thus, the number of Risso's dolphins predicted to experience effects by the acoustic analysis is likely an overestimate.

AFAST sources are transient as active sonar activities pass through an area. Although these marine mammals may exhibit a reaction when exposed to sound from AFAST active sonar activities, the exposures are not expected to be long-term due to the relatively short duration of potential exposures.

The Navy evaluated potential exposures to stocks based on the best estimate for each stock of marine mammal species, as published in the stock assessment reports by NMFS. Risso's dolphins are currently considered as a single stock in the western North Atlantic; the northern Gulf of Mexico population is considered a single stock as well. The best abundance estimate for Risso's dolphins in the western North Atlantic is 20,479 (Waring et al., 2007). The best estimate of abundance for Risso's dolphins in the northern Gulf of Mexico is 1,589 (Waring et al., 2008).

Based on best available science, the Navy concludes that exposures to Risso's dolphins due to AFAST active sonar activities would generally result in only short-term effects to individuals exposed and would likely not affect annual rates of recruitment or survival. The mitigations presented in Chapter 5 will further reduce the potential for exposures to occur to Risso's dolphins.

In accordance with NEPA, there will be no significant impact to Risso's dolphins from AFAST active sonar activities in territorial waters under the No Action Alternative, Alternative 1, Alternative 2, or Alternative 3. Further, in accordance with EO 12114, there will be no significant harm to Risso's dolphins from AFAST active sonar activities in non-territorial waters under the No Action Alternative, Alternative 1, Alternative 2, or Alternative 3. The Navy initiated consultation with NMFS in accordance with the MMPA.

4.4.10.4.15 Atlantic White-Sided Dolphin

Acoustic analysis indicates that up to 20,641 Atlantic white-sided dolphins may be exposed to levels of sound likely to result in Level B harassment under the No Action Alternative, 46 under Alternative 1, 46 under Alternative 2, and 20,461 under Alternative 3. The exposure estimates for each alternative represents the total number of exposures and not necessarily the number of individuals exposed, as a single individual may be exposed multiple times over the course of a year. Acoustic analysis indicates that no Atlantic white-sided dolphins will be exposed to sound levels likely to result in Level A harassment. Modeling of the explosive source sonobuoys (AN/SSQ-110A) predicts no potential for mortality to Atlantic white-sided dolphins.

Atlantic white-sided dolphins belong to the mid-frequency cetacean functional hearing group. This species is likely to hear all sources used during AFAST active sonar activities.

Group size of Atlantic white-sided dolphins can exceed 500 individuals offshore with smaller groups inshore (Wynn and Schwartz, 1999). Given their typical group size and conspicuous surface activity of breaching and bowriding (Wynn and Schwartz, 1999), it is likely that lookouts would detect a group of Atlantic white-sided dolphins at the surface. Implementation of mitigation measures and probability of detecting large groups of white-sided dolphins reduce the likelihood of exposure. Refer to Section 5.4 for additional information on mitigation effectiveness. Thus, the number of Atlantic white-sided dolphins predicted to experience effects by the acoustic analysis is likely an overestimate.

AFAST sources are transient as active sonar activities pass through an area. Although these marine mammals may exhibit a reaction when exposed to sound from AFAST active sonar activities, the exposures are not expected to be long-term due to the relatively short duration of potential exposures.

The Navy evaluated potential exposures to stocks based on the best estimate for each stock of marine mammal species, as published in the stock assessment reports by NMFS. Three stock units have been suggested for the Atlantic white-sided dolphin in the western North Atlantic: Gulf of Maine, Gulf of St. Lawrence, and Labrador Sea (Palka et al., 1997; Waring et al., 2004). However, recent mitochondrial DNA analysis indicates that no definite stock structure exists (Amaral et al., 2001). The best abundance estimate for Atlantic white-sided dolphins in the western North Atlantic is 63,368 animals (Waring et al., 2008). Atlantic white-sided dolphins are not expected to occur in the northern Gulf of Mexico.

Based on best available science, the Navy concludes that exposures to Atlantic white-sided dolphins due to AFAST active sonar activities would generally result in only short-term effects to individuals exposed and would likely not affect annual rates of recruitment or survival. The mitigations presented in Chapter 5 will further reduce the potential for exposures to occur to Atlantic white-sided dolphins.

In accordance with NEPA, there will be no significant impact to Atlantic white-sided dolphins from AFAST active sonar activities in territorial waters under the No Action Alternative, Alternative 1, Alternative 2, or Alternative 3. Further, in accordance with EO 12114, there will be no significant harm to Atlantic white-sided dolphins from AFAST active sonar activities in non-territorial waters under the No Action Alternative, Alternative 1, Alternative 2, or Alternative 3. The Navy initiated consultation with NMFS in accordance with the MMPA.

4.4.10.4.16 Atlantic White-Beaked Dolphin

Acoustic analysis indicates that up to 3,450 Atlantic white-beaked dolphins may be exposed to levels of sound likely to result in Level B harassment under the No Action Alternative, 3,336 under Alternative 1, 3,336 under Alternative 2, and 3,409 under Alternative 3. The exposure estimates for each alternative represents the total number of exposures and not necessarily the number of individuals exposed, as a single individual may be exposed multiple times over the course of a year. Acoustic analysis indicates that no Atlantic white-beaked dolphins will be exposed to sound levels likely to result in Level A harassment. Modeling of the explosive source sonobuoys (AN/SSQ-110A) predicts no potential for mortality to Atlantic white-beaked dolphins.

This species is typically found only in cold-temperate and sub-arctic waters in the North Atlantic. In the western North Atlantic, white-beaked dolphins occur from eastern Greenland and Davis Strait to southern New England. They are generally found in the northern portion of this range between spring and late fall, apparently wintering in the southern portion. Off the northeastern United States, white-beaked dolphin sightings are concentrated in the western Gulf of Maine and around Cape Cod. Prior to the 1970s, this species was found primarily over the continental shelf. However, since then, their distribution has shifted to waters over the continental slope.

Atlantic white-beaked dolphins belong to the mid-frequency cetacean functional hearing group. This species is likely to hear all sources used during AFAST active sonar activities.

Group size of up to 30 white-beaked dolphins is common, but groups of several hundred or thousands of animals have been recorded. This species is also typically active at the surface (Perrin et al., 2002). Therefore, lookouts would likely detect white-beaked dolphins at the surface, thus reducing the likelihood of exposure. Refer to Section 5.4 for additional information on mitigation effectiveness.

AFAST sources are transient as active sonar activities pass through an area. Although these marine mammals may exhibit a reaction when exposed to sound from AFAST active sonar activities, the exposures are not expected to be long-term due to the relatively short duration of potential exposures.

The total number of white-beaked dolphins in U.S. waters is unknown. The best and only recent abundance estimate for the western North Atlantic white-beaked dolphin is 2,003, an estimate derived aerial survey data collected in August 2006. However, it is assumed this estimate is negatively biased because the survey only covered part of the species' habitat (Waring et al., 2007). This species does not occur in the Gulf of Mexico.

Based on best available science, the Navy concludes that exposures to white-beaked dolphins due to AFAST active sonar activities would generally result in short-term effects to individuals exposed and would likely not affect annual rates of recruitment or survival. The mitigations presented in Chapter 5 will further reduce the potential for exposures to occur to white-beaked dolphins.

In accordance with NEPA, there will be no significant impact to white-beaked dolphins from AFAST active sonar activities in territorial waters under the No Action Alternative, Alternative 1, Alternative 2, or Alternative 3. Further, in accordance with EO 12114, there will be no significant harm to white-beaked dolphins from AFAST active sonar activities in non-territorial waters under the No Action Alternative, Alternative 1, Alternative 2, or Alternative 3. The Navy initiated consultation with NMFS in accordance with the MMPA.

4.4.10.4.17 Melon-Headed Whale

Acoustic analysis indicates that up to 1,642 melon-headed whales may be exposed to levels of sound likely to result in Level B harassment under the No Action Alternative, 1,624 under Alternative 1, 196 under Alternative 2, and 1,618 under Alternative 3. The exposure estimates for each alternative represents the total number of exposures and not necessarily the number of individuals exposed, as a single individual may be exposed multiple times over the course of a year. Acoustic analysis indicates that no melon-headed whales will be exposed to sound levels likely to result in Level A harassment. Modeling of the explosive source sonobuoys (AN/SSQ-110A) predicts no potential for mortality to melon-headed whales.

Melon-headed whales belong to the mid-frequency cetacean functional hearing group. This species is likely to hear all sources used during AFAST active sonar activities.

Melon-headed whales are typically found in large groups of between 150 and 1,500 individuals (Perryman et al., 1994; Gannier, 2002), although Watkins et al. (1997) described smaller groups of 10 to 14 individuals. These animals often log at the water's surface in large schools composed of subgroups. Given their large body size, gregarious behavior, and large group size, it is likely that lookouts would detect a group of melon-headed whales at the surface. Implementation of mitigation measures and probability of detecting large groups of melon-headed whales reduce the likelihood of exposure. Refer to Section 5.4 for additional information on mitigation effectiveness. Thus, the number of melon-headed whales predicted to experience effects by the acoustic analysis is likely an overestimate.

AFAST sources are transient as active sonar activities pass through an area. Although these marine mammals may exhibit a reaction when exposed to sound from AFAST active sonar activities, the exposures are not expected to be long-term due to the relatively short duration of potential exposures.

The Navy evaluated potential exposures to stocks based on the best estimate for each stock of marine mammal species, as published in the stock assessment reports by NMFS. Melon-headed whales are currently considered as a single stock in the western North Atlantic; the northern Gulf of Mexico population is considered a single stock as well. North Atlantic and northern Gulf of Mexico populations are considered separate stocks for management purposes although there is currently not enough information to distinguish these stocks. There are no abundance estimates for melon-headed whales in the western North Atlantic (Waring et al., 2007). The best estimate of abundance for melon-headed whales in the northern Gulf of Mexico is 2,283 individuals (Waring et al., 2008).

Based on best available science, the Navy concludes that exposures to melon-headed whales due to AFAST active sonar activities would generally result in only short-term effects to individuals exposed and would likely not affect annual rates of recruitment or survival. The mitigations presented in Chapter 5 will further reduce the potential for exposures to occur to melon-headed whales.

In accordance with NEPA, there will be no significant impact to melon-headed whales from AFAST active sonar activities in territorial waters under the No Action Alternative, Alternative 1, Alternative 2, or Alternative 3. Further, in accordance with EO 12114, there will be no significant harm to melon-headed whales from AFAST active sonar activities in non-territorial waters under the No Action Alternative, Alternative 1, Alternative 2, or Alternative 3. The Navy initiated consultation with NMFS in accordance with the MMPA.

4.4.10.4.18 Pygmy Killer Whale

Acoustic analysis indicates that up to 236 pygmy killer whales may be exposed to levels of sound likely to result in Level B harassment under the No Action Alternative, 233 under Alternative 1, 28 under Alternative 2, and 233 under Alternative 3. The exposure estimates for each alternative represents the total number of exposures and not necessarily the number of individuals exposed, as a single individual may be exposed multiple times over the course of a year. Acoustic analysis indicates that no pygmy killer whales will be exposed to sound levels likely to result in Level A harassment. Modeling of the explosive source sonobuoys (AN/SSQ-110A) predicts no potential for mortality to pygmy killer whales.

Pygmy killer whales belong to the mid-frequency cetacean functional hearing group. This species is likely to hear all sources used during AFAST active sonar activities.

Pygmy killer whales are typically found in groups of up to 50 individuals (Perrin et al., 2002). Given their large body size, gregarious behavior, and group size, it is likely that lookouts would detect a group of pygmy killer whales at the surface. Implementation of mitigation measures and probability of detecting groups of pygmy killer whales reduce the likelihood of exposure. Refer to Section 5.4 for additional information on mitigation effectiveness. Thus, the number of pygmy killer whales predicted to experience effects by the acoustic analysis is likely an overestimate.

AFAST sources are transient as active sonar activities pass through an area. Although these marine mammals may exhibit a reaction when exposed to sound from AFAST active sonar activities, the exposures are not expected to be long-term due to the relatively short duration of potential exposures.

The Navy evaluated potential exposures to stocks based on the best estimate for each stock of marine mammal species, as published in the stock assessment reports by NMFS. Pygmy killer whales are currently considered as a single stock in the western North Atlantic; the northern Gulf of Mexico population is considered a single stock as well. North Atlantic and northern Gulf of Mexico populations are considered separate stocks for management purposes although there is currently not enough information to distinguish these stocks. There is no estimate of abundances for pygmy killer whales in the western North Atlantic (Waring et al., 2007). The best estimate of abundance for pygmy killer whales in the northern Gulf of Mexico is 323 individuals (Waring et al., 2008).

Based on best available science, the Navy concludes that exposures to pygmy killer whales due to AFAST active sonar activities would generally result in only short-term effects to individuals exposed and would likely not affect annual rates of recruitment or survival. The mitigations presented in Chapter 5 will further reduce the potential for exposures to occur to pygmy killer whales.

In accordance with NEPA, there will be no significant impact to pygmy killer whales from AFAST active sonar activities in territorial waters under the No Action Alternative, Alternative 1, Alternative 2, or Alternative 3. Further, in accordance with EO 12114, there will be no significant harm to pygmy killer whales from AFAST active sonar activities in non-territorial waters under the No Action Alternative, Alternative 1, Alternative 2, or Alternative 3. The Navy initiated consultation with NMFS in accordance with the MMPA.

4.4.10.4.19 False Killer Whale

Acoustic analysis indicates that up to 494 false killer whales may be exposed to levels of sound likely to result in Level B harassment under the No Action Alternative, 488 under Alternative 1, 59 under Alternative 2, and 487 under Alternative 3. The exposure estimates for each alternative represents the total number of exposures and not necessarily the number of individuals exposed, as a single individual may be exposed multiple times over the course of a year. Acoustic analysis indicates that no false killer whales will be exposed to sound levels likely to result in Level A harassment. Modeling of the explosive source sonobuoys (AN/SSQ-110A) predicts no potential for mortality to false killer whales.

False killer whales belong to the mid-frequency cetacean functional hearing group. This species is likely to hear all sources used during AFAST active sonar activities.

False killer whales may occur in groups as large as 1,000 individuals (Cummings and Fish, 1971), although groups of tens to hundreds are described in Wynn and Schwartz, 1999. Given their large body size, gregarious behavior, and group size, it is likely that lookouts would detect a group of false killer whales at the surface. Implementation of mitigation measures and probability of detecting large groups of false killer whales reduce the likelihood of exposure. Refer to Section 5.4 for additional information on mitigation effectiveness. Thus, the number of false killer whales predicted to experience effects by the acoustic analysis is likely an overestimate.

AFAST sources are transient as active sonar activities pass through an area. Although these marine mammals may exhibit a reaction when exposed to sound from AFAST active sonar activities, the exposures are not expected to be long-term due to the relatively short duration of potential exposures.

The Navy evaluated potential exposures to stocks based on the best estimate for each stock of marine mammal species, as published in the stock assessment reports by NMFS. NMFS does not include false killer whales among those species having populations or stocks in the Western North Atlantic. Thus, the above exposure estimates pertain only to false killer whales in the Gulf of Mexico. False killer whales are currently considered as a single stock in the northern Gulf of Mexico. There is no estimate of abundances for false killer whales in the western North Atlantic (Waring et al., 2007). The best estimate of abundance for false killer whales in the northern Gulf of Mexico is 777 individuals (Waring et al., 2008).

Based on best available science, the Navy concludes that exposures to false killer whales due to AFAST active sonar activities would generally result in only short-term effects to individuals exposed and would likely not affect annual rates of recruitment or survival. The mitigations presented in Chapter 5 will further reduce the potential for exposures to occur to false killer whales.

In accordance with NEPA, there will be no significant impact to false killer whales from AFAST active sonar activities in territorial waters under the No Action Alternative, Alternative 1, Alternative 2, or Alternative 3. Further, in accordance with EO 12114, there will be no significant harm to false killer whales from AFAST active sonar activities in non-territorial waters under the No Action Alternative, Alternative 1, Alternative 2, or Alternative 3. The Navy initiated consultation with NMFS in accordance with the MMPA.

4.4.10.4.20 Killer Whale

Acoustic analysis indicates that up to 63 killer whales may be exposed to levels of sound likely to result in Level B harassment under the No Action Alternative, 63 under Alternative 1, eight under Alternative 2, and 62 under Alternative 3. The exposure estimates for each alternative represents the total number of exposures and not necessarily the number of individuals exposed, as a single individual may be exposed multiple times over the course of a year. Acoustic analysis indicates that no killer whales will be exposed to sound levels likely to result in Level A harassment. Modeling of the explosive source sonobuoys (AN/SSQ-110A) predicts no potential for mortality to killer whales.

Killer whales belong to the mid-frequency cetacean functional hearing group. This species is likely to hear all sources used during AFAST active sonar activities.

Killer whale group size appears to vary geographically, and ranges from 10 to 40 individuals (Katona et al., 1988; O'Sullivan and Mullin, 1997). Given their large body size, gregarious behavior, and group size, it is likely that lookouts would detect a group of killer whales at the surface. Implementation of mitigation measures and probability of detecting groups of killer whales reduce the likelihood of exposure. Refer to Section 5.4 for additional information on mitigation effectiveness. Thus, the number of killer whales predicted to experience effects by the acoustic analysis is likely an overestimate.

AFAST sources are transient as active sonar activities pass through an area. Although these marine mammals may exhibit a reaction when exposed to sound from AFAST active sonar activities, the exposures are not expected to be long-term due to the relatively short duration of potential exposures.

The Navy evaluated potential exposures to stocks based on the best estimate for each stock of marine mammal species, as published in the stock assessment reports by NMFS. There are no estimates of abundance for killer whales in the western North Atlantic (Waring et al., 2007). Killer whales are currently considered as a single stock in the northern Gulf of Mexico. The best estimate of abundance for killer whales in the northern Gulf of Mexico is 49 individuals (Waring et al., 2008).

Based on best available science, the Navy concludes that exposures to killer whales due to AFAST active sonar activities would generally result in only short-term effects to individuals exposed and would likely not affect annual rates of recruitment or survival. The mitigations presented in Chapter 5 will further reduce the potential for exposures to occur to killer whales.

In accordance with NEPA, there will be no significant impact to killer whales from AFAST active sonar activities in territorial waters under the No Action Alternative, Alternative 1, Alternative 2, or Alternative 3. Further, in accordance with EO 12114, there will be no significant harm to killer whales from AFAST active sonar activities in non-territorial waters under the No Action Alternative, Alternative 1, Alternative 2, or Alternative 3. The Navy initiated consultation with NMFS in accordance with the MMPA.

4.4.10.4.21 Long-Finned and Short-Finned Pilot Whales

Acoustic analysis indicates that up to 127,393 long-finned and short-finned pilot whales may be exposed to levels of sound likely to result in Level B harassment under the No Action Alternative, 94,953 under Alternative 1, 97,885 under Alternative 2, and 122,100 under Alternative 3. The exposure estimates for each alternative represents the total number of exposures and not necessarily the number of individuals exposed, as a single individual may be exposed multiple times over the course of a year. Acoustic analysis indicates that up to 11 long-finned and short-finned pilot whales may be exposed to levels of sound likely to result in Level A harassment under the No Action Alternative, eight under Alternative 1, eight under Alternative 2, and ten under Alternative 3. Modeling of the explosive source sonobuoys (AN/SSQ-110A) predicts no potential for mortality to long-finned and short-finned pilot whales.

Pilot whales belong to the mid-frequency cetacean functional hearing group. This species is likely to hear all sources used during AFAST active sonar activities.

Pilot whale group size typically ranges from several to several hundred individuals (Jefferson et al., 1993; Wynn and Schwartz, 1999). Given their large body size, gregarious behavior, and group size, it is likely that lookouts would detect a group of pilot whales at the surface. Implementation of mitigation measures and probability of detecting groups of pilot whales reduce the likelihood of exposure. Refer to Section 5.4 for additional information on mitigation effectiveness. Thus, the number of pilot whales predicted to experience effects by the acoustic analysis is likely an overestimate.

AFAST sources are transient as active sonar activities pass through an area. Although these marine mammals may exhibit a reaction when exposed to sound from AFAST active sonar activities, the exposures are not expected to be long-term due to the relatively short duration of potential exposures.

The Navy evaluated potential exposures to stocks based on the best estimate for each stock of marine mammal species, as published in the stock assessment reports by NMFS. Pilot whales occur in both the western North Atlantic and northern Gulf of Mexico. Short-finned pilot whales occur in both water bodies, while long-finned pilot whales occur only in the North Atlantic. Fullard et al. (2000) proposed a stock structure for long-finned pilot whales in the North Atlantic that was correlated with sea-surface temperature. This involved a cold-water population west of the Labrador and North Atlantic current and a warm-water population that extended across the North Atlantic in the warmer water of the Gulf Stream. There is no information regarding genetic differentiation within the western North Atlantic stock (Waring et al., 2004). Short-finned pilot whales are currently considered as a single stock in the western North Atlantic; the northern Gulf of Mexico population is considered a single stock as well. North Atlantic and northern Gulf of Mexico populations are considered separate stocks for management purposes although there is currently not enough information to distinguish these stocks. The best estimate of abundance for pilot whales (combined short-finned and long-finned) in the western North Atlantic is 31,139 individuals (Waring et al., 2008). The best estimate of abundance for the short-finned pilot whale in the northern Gulf of Mexico is 716 individuals (Waring et al., 2008).

Based on best available science, the Navy concludes that exposures to pilot whales due to AFAST active sonar activities would generally result in only short-term effects to individuals exposed and would likely not affect annual rates of recruitment or survival. The mitigations presented in Chapter 5 will further reduce the potential for exposures to occur to pilot whales

In accordance with NEPA, there will be no significant impact to long-finned and short-finned pilot whales from AFAST active sonar activities in territorial waters under the No Action Alternative, Alternative 1, Alternative 2, or Alternative 3. Further, in accordance with EO 12114, there will be no significant harm to long-finned and short-finned pilot whales from AFAST active sonar activities in non-territorial waters under the No Action Alternative, Alternative 1, Alternative 2, or Alternative 3. The Navy initiated consultation with NMFS in accordance with the MMPA.

4.4.10.4.22 Harbor Porpoise

Acoustic analysis indicates that up to 152,370 harbor porpoises may be exposed to levels of sound likely to result in Level B harassment under the No Action Alternative, 28 under Alternative 1 and Alternative 2, and 152,706 under Alternative 3. The exposure estimates for each alternative represents the total number of exposures and not necessarily the number of individuals exposed, as a single individual may be exposed multiple times over the course of a year. Acoustic analysis indicates that no harbor porpoises will be exposed to sound levels likely to result in Level A harassment. Modeling of the explosive source sonobuoys (AN/SSQ-110A) predicts no potential for mortality to harbor porpoises.

Harbor porpoises are in the high-frequency cetacean functional hearing group. This species is likely to hear all sources used during AFAST active sonar activities.

Lookouts may not readily see harbor porpoises because they are small and cryptic. Refer to Section 5.4 for additional information on mitigation effectiveness.

AFAST sources are transient as active sonar activities pass through an area. Although these marine mammals may exhibit a reaction when exposed to sound from AFAST active sonar activities, the exposures are not expected to be long-term due to the relatively short duration of potential exposures.

The Navy evaluated potential exposures to stocks based on the best estimate for each stock of marine mammal species, as published in the stock assessment reports by NMFS. Harbor porpoises do not occur in the Gulf of Mexico. There are four proposed separate populations of harbor porpoises in the western North Atlantic: Gulf of Maine/Bay of Fundy, Gulf of St. Lawrence, Newfoundland, and Greenland (Gaskin, 1992). During summer, harbor porpoises are concentrated in the Gulf of Maine/Bay of Fundy region, generally in waters less than 150 m (492 ft) deep (Kraus et al., 1983; Palka, 1995a, b). During fall and spring, they are widely dispersed from New Jersey to Maine, with lower densities farther north and south. At this time, they occur from the coastline to deeper waters (greater than 1800 m [5,905 ft]) (Westgate et al., 1998). During winter, intermediate densities of harbor porpoises occur in waters off New Jersey to North Carolina, with lower densities off New York to New Brunswick, Canada. There does not appear to be coordinated migration or a specific migratory route to and from the Bay of Fundy region. The best abundance estimate for the Gulf of Maine/Bay of Fundy stock of harbor porpoises is 89,054 individuals (Waring et al., 2008).

Based on best available science, the Navy concludes that exposures to harbor porpoises due to AFAST active sonar activities would generally result in only short-term effects to individuals exposed and would likely not affect annual rates of recruitment or survival. The mitigations presented in Chapter 5 will further reduce the potential for exposures to occur to harbor porpoises.

In accordance with NEPA, there will be no significant impact to harbor porpoises from AFAST active sonar activities in territorial waters under the No Action Alternative, Alternative 1, Alternative 2, or Alternative 3. Further, in accordance with EO 12114, there will be no significant harm to harbor porpoises from AFAST active sonar activities in non-territorial waters under the No Action Alternative, Alternative 1, Alternative 2, or Alternative 3. The Navy initiated consultation with NMFS in accordance with the MMPA.

4.4.10.4.23 Hooded Seal

The best abundance estimate for hooded seals in the western North Atlantic Ocean is 592,100 (Waring et al., 2007). Present data are insufficient to calculate the minimum population estimate in U.S. waters. Because of this no density data was able to be derived and no quantitative acoustic analysis was possible for AFAST active sonar activities. Although individual hooded seals may travel far outside their typical range and have been sighted as far south as Puerto Rico and the Virgin Islands, they generally occur in the Atlantic region of the Arctic Ocean and in high latitudes of the North Atlantic near the outer edge of the pack ice. Hooded seals occur with regularity only in the Northeast OPAREA (from northern Maine to southern Delaware), primarily during winter. Sightings off the northeastern United States have generally increased in recent years. An undetermined number of hooded seals could be exposed to sound levels likely to result in Level B harassment. However, because on their distribution, the relative number of potential exposures is probably low. No exposure of individuals to sound levels likely to result in Level A harassment is expected. No mortality due to explosive sonobuoys (AN/SSQ-110A) is expected.

Hooded seals belong to the pinniped functional hearing group, with in-water functional hearing estimated to occur between approximately 75 Hz and 75 kHz, with the greatest sensitivity between approximately 700 Hz and 20 kHz. Although some high-frequency active sonars may be above this species hearing range, these sources are not used within this species regular occurrence area.

Lookouts may not readily see hooded seals because they are small, solitary, and usually only present a small portion of their body to breathe. Refer to Section 5.4 for additional information on mitigation effectiveness.

Based on best available science, the Navy concludes that exposures to hooded seals due to AFAST active sonar activities would generally result in short-term effects to individuals exposed and would likely not affect annual rates of recruitment or survival. The mitigations presented in Chapter 5 will further reduce the potential for exposures to occur to hooded seals.

In accordance with NEPA, there will be no significant impact to hooded seals from AFAST active sonar activities in territorial waters under the No Action Alternative, Alternative 1, Alternative 2, or Alternative 3. Further, in accordance with EO 12114, there will be no significant harm to hooded seals from AFAST active sonar activities in non-territorial waters under the No Action Alternative, Alternative 1, Alternative 2, or Alternative 3. The Navy initiated consultation with NMFS in accordance with the MMPA.

4.4.10.4.24 Harp Seal

The best abundance estimate for harp seals in the western North Atlantic Ocean is 5.5 million (Waring et al., 2008). Present data are insufficient to calculate the minimum population estimate in U.S. waters. Because of this no density data was able to be derived and no quantitative acoustic analysis was possible for AFAST active sonar activities. Harp seals are closely associated with pack ice of the North Atlantic and Arctic Oceans, from Newfoundland and the Gulf of St. Lawrence to northern Russia. Most of the western North Atlantic harp seals congregate off the east coast of Newfoundland-Labrador to pup and breed; the remainder gather near the Magdalen Islands in the Gulf of St. Lawrence. This species undergoes extensive spring and fall migrations to and from summer feeding and pupping grounds in sub-arctic and arctic waters.

The number of sightings and strandings of harp seals off the northeastern United States has been increasing, particularly in winter and early spring when the western North Atlantic stock is at its southernmost distribution point. They may occur in the Northeast OPAREA, from the northern coast of Maine to the southern coast of Delaware during winter and spring, and from the southern coast of Maine to Long Island during fall. An undetermined number of harp seals could be exposed to sound levels likely to result in Level B harassment, although this species' northerly distribution would result in relatively few exposures. No exposure of individuals to sound levels likely to result in Level A harassment is expected. No mortality due to explosive sonobuoys is expected.

Harp seals belong to the pinniped functional hearing group, with in-water functional hearing estimated to occur between approximately 75 Hz and 75 kHz, with the greatest sensitivity between approximately 700 Hz and 20 kHz. Although some high-frequency active sonars may be above this species hearing range, these sources are not used within this species regular occurrence area.

Lookouts may not readily see Harp seals because they are small, solitary, and usually only present a small portion of their body to breathe. Refer to Section 5.4 for additional information on mitigation effectiveness.

Based on best available science, the Navy concludes that exposures to harp seals due to AFAST active sonar activities would generally result in short-term effects to individuals exposed and would likely not affect annual rates of recruitment or survival. The mitigations presented in Chapter 5 will further reduce the potential for exposures to occur to harp seals.

In accordance with NEPA, there will be no significant impact to harp seals from AFAST active sonar activities in territorial waters under the No Action Alternative, Alternative 1, Alternative 2, or Alternative 3. Further, in accordance with EO 12114, there will be no significant harm to harp seals from AFAST active sonar activities in non-territorial waters under the No Action Alternative, Alternative 1, Alternative 2, or Alternative 3. The Navy initiated consultation with NMFS in accordance with the MMPA.

4.4.10.4.25 Gray Seal

Acoustic analysis indicates that up to 7,859 gray seals may be exposed to levels of sound likely to result in Level B harassment under the No Action Alternative, 1,454 under Alternative 1, 1,454 under Alternative 2, and 8,440 under Alternative 3. The exposure estimates for each alternative represents the total number of exposures and not necessarily the number of individuals exposed, as a single individual may be exposed multiple times over the course of a year. Acoustic analysis indicates that no gray seals may be exposed to levels of sound likely to result in Level A harassment. Modeling of the explosive source sonobuoys (AN/SSQ-110A) predicts no potential for mortality to gray seals.

Gray seals belong to the pinniped functional hearing group, with in-water functional hearing estimated to occur between approximately 75 Hz and 75 kHz, with the greatest sensitivity between approximately 700 Hz and 20 kHz. Although some high-frequency active sonars may be above this species hearing range, these sources are not used within this species regular occurrence area.

Lookouts may not readily see gray seals because they are small, solitary, and usually only present a small portion of their body to breathe. Refer to Section 5.4 for additional information on mitigation effectiveness.

AFAST sources are transient as active sonar activities pass through an area. Although these marine mammals may exhibit a reaction when exposed to sound from AFAST active sonar activities, the exposures are not expected to be long-term due to the relatively short duration of potential exposures.

The Navy evaluated potential exposures to stocks based on the best estimate for each stock of marine mammal species, as published in the stock assessment reports by NMFS. Gray seals do not occur in the Gulf of Mexico. There are at least three populations of gray seals in the North Atlantic Ocean: eastern North Atlantic, western North Atlantic, and Baltic (Boskovic et al., 1996). The western North Atlantic stock is equivalent to the eastern Canada breeding population (Waring et al., 2007). There are two breeding concentrations in eastern Canada: one at Sable Island and the other on the pack ice in the Gulf of St. Lawrence. These two breeding groups are treated as separate populations for management purposes (Mohn and Bowen, 1996). Current estimates of the gray seal population in the western North Atlantic are not available, but the population in U.S. waters is increasing.

Based on best available science, the Navy concludes that exposures to gray seals due to AFAST active sonar activities would generally result in only short-term effects to individuals exposed and would likely not affect annual rates of recruitment or survival. The mitigations presented in Chapter 5 will further reduce the potential for exposures to occur to gray seals.

In accordance with NEPA, there will be no significant impact to gray seals from AFAST active sonar activities in territorial waters under the No Action Alternative, Alternative 1, Alternative 2, or Alternative 3. Further, in accordance with EO 12114, there will be no significant harm to gray seals from AFAST active sonar activities in non-territorial waters under the No Action Alternative, Alternative 1, Alternative 2, or Alternative 3. The Navy initiated consultation with NMFS in accordance with the MMPA.

4.4.10.4.26 Harbor Seal

Acoustic analysis indicates that up to 12,659 harbor seals may be exposed to levels of sound likely to result in Level B harassment under the No Action Alternative, 762 under Alternative 1, 762 under Alternative 2, and 12,698 under Alternative 3. The exposure estimates for each alternative represents the total number of exposures and not necessarily the number of individuals exposed, as a single individual may be exposed multiple times over the course of a year. Acoustic analysis indicates that no harbor seals may be exposed to levels of sound likely to result in Level A harassment. Modeling of the explosive sonobuoys (AN/SSQ-110A) predicts no potential for mortality to the harbor seal.

Harbor seals belong to the pinniped functional hearing group, with in-water functional hearing estimated to occur between approximately 75 Hz and 75 kHz, with the greatest sensitivity between approximately 700 Hz and 20 kHz. Although some high-frequency active sonars may be above this species hearing range, these sources are not used within this species regular occurrence area.

Lookouts may not readily see harbor seals because they are small, solitary, and usually only present a small portion of their body to breathe. Refer to Section 5.4 for additional information on mitigation effectiveness.

AFAST sources are transient as active sonar activities pass through an area. Although these marine mammals may exhibit a reaction when exposed to sound from AFAST active sonar activities, the exposures are not expected to be long-term due to the relatively short duration of potential exposures.

The Navy evaluated potential exposures to stocks based on the best estimate for each stock of marine mammal species, as published in the stock assessment reports by NMFS. Harbor seals do not occur in the Gulf of Mexico. Five species of harbor seals are recognized; *Phoca vitulina concolor* is the western North Atlantic subspecies (Rice, 1998). Currently, harbor seals that occur along the coast of the eastern United States and Canada are considered to be a single population (Waring et al., 2008). The best abundance estimate for harbor seals in the western North Atlantic is 99,340, with a minimum population estimate of 91,546 animals (Waring et al., 2008).

Based on best available science, the Navy concludes that exposures to harbor seals due to AFAST active sonar activities would generally result in only short-term effects to individuals exposed and would likely not affect annual rates of recruitment or survival. The mitigations presented in Chapter 5 will further reduce the potential for exposures to occur to harbor seals.

In accordance with NEPA, there will be no significant impact to harbor seals from AFAST active sonar activities in territorial waters under the No Action Alternative, Alternative 1, Alternative 2, or Alternative 3. Further, in accordance with EO 12114, there will be no significant harm to harbor seals from AFAST active sonar activities in non-territorial waters under the No Action Alternative, Alternative 1, Alternative 2, or Alternative 3. The Navy initiated consultation with NMFS in accordance with the MMPA.

4.4.11 Other Potential Acoustic Effects to Marine Mammals

4.4.11.1 Ship Noise

Increased numbers of ships operating in the area will result in increased sound from vessel traffic. Marine mammals react to vessel-generated sounds in a variety of ways. Some respond negatively by retreating or engaging in antagonistic responses while other animals ignore the stimulus altogether (Watkins, 1986; Terhune and Verboom, 1999).

Most studies have ascertained the short-term response to vessel sound and vessel traffic (Watkins et al., 1981; Baker et al., 1983; Magalhães et al., 2002); however, the long-term implications of ship sound on marine mammals are largely unknown (NMFS, 2007a).

Anthropogenic sound has increased in the marine environment over the past 50 years (NRC Richardson et al., 1995; 2003). This sound increase can be attributed to increases in vessel traffic as well as sound from marine dredging and construction, oil and gas drilling, geophysical surveys, sonar, and underwater explosions (Richardson et al., 1995).

Given the current ambient sound levels in the marine environment, the amount of sound contributed by the use of Navy vessels in the proposed exercises is very low. It is anticipated that any marine mammals exposed may exhibit only short-term reactions and would not suffer any long-term consequences from ship sound.

4.4.11.2 Potential for Long-Term Effects

Some AFAST training activities will be conducted in the same general areas, so marine mammal populations or a single marine mammal could experience multiple exposures to repeated activities over time. However, as described earlier, the acoustic analyses assume that short-term noninjurious SELs predicted to cause TTS or temporary behavioral disruptions qualify as Level B harassment. Application of this criterion assumes an effect even though it is highly unlikely that all behavioral disruptions or instances of TTS will result in long-term significant effects. Although long-term effects have not been studied, the Navy is coordinating both the short- and long-term monitoring of marine mammals on various established ranges and OPAREAs to determine the response of marine mammals to Navy sound sources. In addition, as part of the Incidental Take Authorization under the MMPA, the Navy will implement a long-term monitoring program for AFAST active sonar activities.

4.4.11.3 Sound in the Water From In-Air Sound

Sound originating in air can be transmitted through the air-sea boundary and can be detected underwater. The type of response a marine mammal may experience depends on many variables, including the location, motion, and type of sound source. For example, bowheads respond more to aircraft noise when in shallow water and humpback whales are less likely to react to a continuous source than a sudden onset (International Council for the Exploration of the Sea [ICES], 2005a). Very few studies have been conducted on the effects aircraft sound may have on marine mammals.

According to one study on the effects of sound from a fixed-wing aircraft on sperm whales, the types of aircraft activities that may elicit a behavioral response include military training exercises, helicopter overflights associated with offshore oil and gas exploration and development, ecotourism flights, and research surveys (Smultea et al., 2008). During three of the 24 sightings (12 percent), a hasty dive was observed from the initial pass of the Skymaster aircraft, all of which occurred less than 360 m (1,181 ft) lateral distance from the aircraft. An additional reaction from one group of 11 sperm whales (including one calf) was observed when the aircraft returned and circled overhead for approximately 4 minutes. The group stopped moving forward and formed a fan-shaped semi-circle with the heads facing out and the calf in the middle. One sperm whale was swimming on its side with its mouth agape. The authors of this study interpreted this behavior as a distress and/or defense reaction to the circling aircraft. This was based on similar behaviors observed in response to the presence of perceived or actual threats such as predators and vessel approaches. They also concluded based on other studies that the individual swimming on its side with the mouth agape was possibly attempting to look up at the aircraft (Smultea et al., 2008).

While these findings can provide better insight into potential behavioral effects from in-air sound, the study does not provide either source levels of sound produced by the aircraft, or received levels of sound from the location of the sperm whales. It only states that based on available data, the frequency range and dominant tones of sound produced by the aircrafts overlap with the low-frequency range of sperm whale vocalizations. Furthermore, the authors concluded that the reactions observed were short-term and not biologically significant (Smultea et al., 2008).

Urick (1972) conducted a field experiment in which a Navy P-3 Orion aircraft flew at speeds of 370 km/hr (200 kn) at altitudes of 76, 152, and 305 m (250, 500, and 1,000 ft). A total of 15 flyovers were made over two hydrophones placed at 17 and 93 m (55 and 305 ft). Of these, one was made at 76 m (250 ft), 13 were made at 152 m (500 ft), and one was made at 305 m (1,000 ft). At 152 m (500 ft), the aircraft noise at the 17 m (55 ft) hydrophone ranged from approximately 74 to 77 dB re 1 μPa-m at 0.68 kHz, and 65 to 69 dB re 1 μPa-m at 1.0 kHz. In addition, the sound had a duration of only a few seconds when observed at this hydrophone depth (Urick, 1972).

Another study investigated the use of low-flying helicopters during mission activities and the potential exposure to marine animals from air-generated sound. To calculate possible received levels of sound by marine species, direct in-water measurements of sound generated by MH-60 helicopters from Navy tests were used (DON, 1999). From these measurements, decibel levels were modeled based on various helicopter altitudes and water depths.

During these tests, an MH-60 flew over calibrated sonobuoys (receiver depth at 122 m [400 ft] at altitudes ranging from 76 to 1,525 m (250 to about 5,000 ft). The resulting underwater sound spectrum levels fell from 80 dB at 0.010 kHz to 60 dB at 0.5 kHz and 28 dB at 5.0 kHz. The total intensity level was approximately 100 dB re μPa^2-s. The sound source level at the helicopter was calculated to be approximately 150 dB re 1 μPa^2-s at 1 m (3.3 ft).

Based on these measurements, decibel levels were modeled using various helicopter altitudes and water depths. Table 4-28 shows the received underwater sound levels generated by an MH-60 hovering at altitudes of 15 and 76 m (50 and 250 ft), which were the lower and upper altitudes of operation for the Navy tests (DON, 1999). Received levels were calculated for points directly below the aircraft. A water depth of 1 m (3.3 ft) was used as a conservative value to simulate the depth of a marine animal just under the surface. The received sound level would be lower at points farther away from the source (in depth and/or in range). As shown in Table 4-28, the maximum underwater sound level potentially experienced is expected to be approximately 130 dB re 1 μPa^2-s.

Table 4-28. Helicopter Sound in Water Total Intensity Levels (dB re 1 μPa^2 s)

Altitude	Source Level (at 1 m)	Depth = 1 m
15 m	150 dB	130 dB
76 m	150 dB	119 dB

dB = decibels; dB re 1 μPa^2-s = decibels referenced to 1 micropascal squared second; m = meters

Regulatory sound level criteria do not exist for nonprotected marine species; however, the exposure to sound in the water from in-air noise will be temporary, short in duration, and will dissipate quickly. *Therefore, there will be no significant impact from in-air sound to marine mammals over territorial waters under the No Action Alternative, Alternative 1, Alternative 2, or Alternative 3.* In addition, there will be no significant harm from in-air sound to marine mammals over non-territorial waters under the No Action Alternative, Alternative 1, Alternative 2, or Alternative 3.

4.4.11.4 Likelihood of Prolonged Exposure

ASW activities would not result in prolonged exposure because the vessels are constantly moving, and the flow of the activity when training occurs reduces the potential for prolonged exposure. The implementation of the protective measures described in Section 5 would further reduce the likelihood of any prolonged exposure.

4.4.12 Potential Nonacoustic Effects to Marine Mammals

Non-acoustic effects analyzed in the AFAST EIS/OEIS included vessel strikes, entanglement from training materials, and water quality effects associated with expended sonobuoy batteries, explosive residuals, and torpedo sodium fluorescein dye. Marine mammals are also subject to entanglement in expended materials, particularly anything incorporating loops or rings, hooks and lines, or sharp objects. Most documented cases of entanglements occur when whales encounter the vertical lines of fixed fishing gear. Possible expended materials from AFAST active sonar activities include sonobuoys, torpedoes, and Acoustic Device Countermeasure (ADCs), and Expendable Mobile Acoustic Training Target (EMATTs).

4.4.12.1 Vessel Strikes

Collisions with commercial and Navy ships can result in serious injury and may occasionally cause fatalities to cetaceans and manatees. Although the most vulnerable marine mammals may be assumed to be slow-moving cetaceans or those that spend extended periods of time at the surface in order to restore oxygen levels within their tissues after deep dives (e.g., sperm whale), fin whales are actually struck most frequently (Laist et al. 2001). Manatees are also particularly susceptible to vessel interactions and collisions with watercraft constitute the leading cause of mortality. Smaller marine mammals such as bottlenose and Atlantic spotted dolphins move more quickly throughout the water column and are often seen riding the bow wave of large ships. Marine mammal responses to vessels may include avoidance and changes in dive pattern (NRC, 2003).

After reviewing historical records and computerized stranding databases for evidence of ship strikes involving baleen and sperm whales, Laist et al. (2001) found that accounts of large whale ship strikes involving motorized vessels date back to at least the late 1800s. Ship collisions remained infrequent until the 1950s, after which point they increased. Laist et al. (2001) reports that both the number and speed of motorized vessels have increased over time for trans-Atlantic passenger services, which transit through the area. They concluded that most strikes occur over or near the continental shelf, that ship strikes likely have a negligible effect on the status of most whale populations, but that for small populations or segments of populations the impact of ship strikes may be significant.

Although ship strike mortalities may represent a small proportion of whale populations, Laist et al. (2001) also concluded that, when considered in combination with other human-related mortalities in the area (e.g., entanglement in fishing gear), these ship strikes may present a concern for whale populations.

Of 11 species known to be hit by ships, fin whales are struck most frequently; right whales, humpback whales, sperm whales, and gray whales are all hit commonly (Laist et al 2001). In some areas, one-third of all fin whale and right whale strandings appear to involve ship strikes. Sperm whales spend long periods (typically up to 10 minutes; Jacquet et al. 1998) "rafting" at the surface between deep dives. This could make them exceptionally vulnerable to ship strikes. Berzin (1972) noted that there were "many" reports of sperm whales of different age classes being struck by vessels, including passenger ships and tug boats. There were also instances in which sperm whales approached vessels too closely and were cut by the propellers (NMFS, 2006b).

Accordingly, the Navy has adopted mitigation measures to reduce the potential for collisions with surfaced marine mammals (for more details refer to Chapter 5). These measures include the following:

- Using lookouts trained to detect all objects on the surface of the water, including marine mammals.
- Implementing reasonable and prudent actions to avoid the close interaction of Navy assets and marine mammals.
- Maneuvering to keep away from any observed marine mammal.

Navy shipboard lookouts (also referred to as "watchstanders") are highly qualified and experienced observers of the marine environment. Their duties require that they report all objects sighted in the water to the Officer of the Deck (e.g., trash, a periscope, marine mammals, sea turtles) and all disturbances (e.g., surface disturbance, discoloration) that may be indicative of a threat to the vessel and its crew. There are personnel serving as lookouts on station at all times (day and night) when a ship or surfaced submarine is moving through the water. Navy lookouts undergo extensive training in order to qualify as a lookout. This training includes on-the-job instruction under the supervision of an experienced lookout, followed by completion of the Personal Qualification Standard program, certifying that they have demonstrated the necessary skills (such as detection and reporting of partially submerged objects).

The Navy includes marine species awareness as part of its training for its bridge lookout personnel on ships and submarines. Lookouts are trained how to look for marine species, and report sightings to the Officer of the Deck so that action may be taken to avoid the marine species or adjust the exercise to minimize effects to the species. Marine Species Awareness Training was updated in 2006, and the additional training materials are now included as required training for Navy ship and submarine lookouts. Additionally, all Commanding Officers and Executive Officers of units involved in training exercises are required to undergo marine species awareness training. This training addresses the lookout's role in environmental protection, laws governing the protection of marine species, Navy stewardship commitments, and general observation information to aid in avoiding interactions with marine species.

Given the low abundance of North Atlantic right whales relative to other species, the frequency of occurrence of vessel collisions to right whales suggests that the threat of ship strikes is proportionally greater to this species (Jensen and Silber, 2003). On average, one or two right whales are killed annually in collisions. Between 2001 and 2005, there were 15 confirmed ship strikes involving North Atlantic right whales. Of those, eight died and one was seriously injured (Nelson et al., 2007). In order to reduce the risk of ship strikes, the Navy has instituted North Atlantic right whale projective measures that cover vessels operating all along the Atlantic coast. Standing protective measures and annual guidance have been in place for ships in the vicinity of the North Atlantic right whale critical habitat off the southeast coast since 1997. In addition to specific operating guidelines, the Navy's efforts in the southeast include funding support to the Early Warning System (EWS), and organization of a communication network and reporting system to ensure the widest possible dissemination of North Atlantic right whale sighting information to the Department of Defense and civilian shipping.

In 2002, North Atlantic right whale protective measures were promulgated for all United States Fleet Forces (USFF) activities occurring in the northeast region. In December 2004, the Navy issued further guidance for all USFF ships to increase awareness of North Atlantic right whale migratory patterns and implement additional protective measures along the mid-Atlantic coast. This includes areas where ships transit between southern New England and northern Florida. Southward right whale migration generally occurs from mid- to late November, although some right whales may arrive off the Florida coast in early November and stay into late March (Kraus et al., 1993). The northbound migration generally takes place between January and late March. Data indicate that during the spring and fall migration, right whales typically occur in shallow water immediately adjacent to the coast, with over half the sightings (63.8 percent) occurring within 18.5 km (10 NM), and 94.1 percent reported within 55 km (30 NM) of the coast.

The Navy coordinated with NMFS for identification of seasonal right whale occurrence patterns in six major sections of the mid-Atlantic coast, with particular attention to port and coastal areas of key interest for vessel traffic management. The Navy's resulting guidance calls for extreme caution and operation at a slow, safe speed within 37 km (20 NM) arcs of specified coastal and port reference points. The guidance reiterates previous instructions that Navy ships post two looksouts, one of whom must have completed marine species awareness training, and emphasizes the need for utmost vigilance in performance of these watchstander duties. In addition, Navy vessels will avoid knowingly approaching any whale head on and will maneuver to keep at least 460 m (1,500 ft) away from any observed whale, consistent with vessel safety.

As stated previously, these measures are similar to vessel transit procedures in place since 1997 for Navy vessels in the vicinity of designated right whale critical habitat in the southeastern United States. Based on the implementation of Navy mitigation measures, especially during times of anticipated right whale occurrence, and the relatively low density of Navy ships in the Study Area, the likelihood that a vessel collision would occur is very low. *Therefore, there will be no significant impact to marine mammals from vessel interactions during AFAST training exercises within territorial waters under the No Action Alternative, Alternative 1, Alternative 2, or Alternative 3*. In addition, there will be no significant harm to marine mammals resulting from vessel interactions during AFAST training exercises in non-territorial waters under the No Action Alternative, Alternative 1, Alternative 2, or Alternative 3. AFAST training with respect to vessel strikes may affect ESA-listed marine mammal species. The Navy is consulting with NMFS in accordance with the MMPA and ESA.

4.4.12.2 Entanglement

Marine mammals are subject to entanglement in expended materials, particularly anything incorporating loops or rings, hooks and lines, or sharp objects. Most documented cases of entanglements occur when whales encounter the vertical lines of fixed fishing gear. Possible expended materials from AFAST active sonar activities include sonobuoys, torpedoes, ADCs, and EMATTs (Table 4-1). Specifically, during torpedo exercises, guidance wires and flex hoses are expended. Moreover, sonobuoy parachutes, lines, and drogues, as well as EMATT parachutes are also expended during AFAST active sonar activities. This section analyzes the potential effects of expended materials on marine mammals.

4.4.12.2.1 Parachutes

Aircraft-launched sonobuoys, torpedoes, and EMATTs use nylon parachutes of varying sizes. At water impact, the parachute assembly is expended, and it sinks away from the unit. The parachute assembly will potentially be at the surface for a short time before sinking to the sea floor. Entanglement and the eventual drowning of a marine mammal in a parachute assembly will be unlikely, since the parachute will have to land directly on an animal, or an animal will have to swim into it before it sinks. The potential for a marine mammal to encounter an expended parachute is extremely low, given the generally low probability of a marine mammal being in the immediate location of deployment, especially given the mitigation measures outlined in Chapter 5.

All of the material is negatively buoyant and will sink to the ocean floor. Many of the components are metallic and will sink rapidly. For instance, IEER system parachutes are weighted with metal clips that assist in their quick descent to the sea floor. The expended material will accumulate on the ocean floor and will be covered by sediments over time, thereby remaining on the ocean floor and reducing the potential for entanglement. This accrual of material is not expected to cause an increased potential for marine mammal entanglement. If bottom currents are present, the canopy may billow (bulge) and pose an entanglement threat to marine animals with bottom-feeding habits; however, the probability of a marine mammal encountering a parachute assembly on the sea floor and the potential for accidental entanglement in the canopy or suspension lines is considered to be unlikely since most marine mammals interact with the sea floor on a limited basis.

Some ingestion of plastics by marine mammals is known to occur. Humpback whales have been speculated to feed on the ocean floor on Stellwagen Bank, in water depths less than 40 m (131 ft). In this area, it is hypothesized that humpbacks either directly touch the bottom or come close enough to it in order to stir up sand lance, a preferred prey (Hain et al., 1995). Right whales have also been suggested to feed near the ocean floor in the Great South Channel on copepods that migrate to deep waters during the day (Baumgartner and Wenzel, 2005). The prey items for each of these species are much smaller in size than the materials that will be expended during an exercise utilizing torpedoes or sonobuoys. Due to the larger size of the expended materials, ingestion is not expected by these bottom or near-bottom feeding species.

The overall possibility of marine mammals ingesting parachute fabric or becoming entangled in cable assemblies is very remote. *Therefore, there will be no significant impact to marine* *mammals resulting from interactions with parachute assemblies during AFAST active sonar activities within territorial waters under the No Action Alternative, Alternative 1, Alternative 2, or Alternative 3*. In addition, there will be no significant harm to marine mammals resulting from interactions with parachute assemblies during AFAST active sonar activities in non-territorial waters under the No Action Alternative, Alternative 1, Alternative 2, or Alternative 3. Parachutes associated with AFAST training may affect ESA-listed marine mammal species.

4.4.12.2.2 Torpedo Guidance Wires

Torpedoes are equipped with a single-strand guidance wire, which is laid behind the torpedo as it moves through the water. At the end of a torpedo run, the wire is released from the firing vessel and the torpedo to enable torpedo recovery. The wire sinks rapidly and settles on the ocean floor. Guidance wires are expended with each exercise torpedo launched. Each year, about 32 exercise torpedoes will be used; therefore, the same number of control wires will be expended annually.
DON (1996) analyzed the potential entanglement effects of torpedo control wires on marine mammals. The Navy analysis concluded that the potential for entanglement effects will be low for the following reasons:

- The guidance wire is a very fine, thin-gauge copper-cadmium core with a polyolefin coating. The tensile breaking strength of the wire is a maximum of 19 kg (42 lb) and can be broken by hand. With the exception of a chance encounter with the guidance wire while it was sinking to the sea floor (at an estimated rate of 0.2 m [0.7 ft] per second), a marine animal would be vulnerable to entanglement only if its diving and feeding patterns place it in contact with the bottom.
- Heezen (as cited in DON, 1996) theorized that the entanglement of marine mammals with undersea cables was a direct result of the mammal coming into contact with loops in the cable (e.g., swimming through loops that then tightened around the mammal). The torpedo control wire is held stationary in the water column by drag forces as it is pulled from the torpedo in a relatively straight line until its length becomes sufficient for it to form a chain-like droop. When the wire is cut or broken, it is relatively straight and the physical characteristics of the wire prevent it from tangling, unlike the monofilament fishing lines and polypropylene ropes identified in the entanglement literatures.

Given the low potential probability of marine mammal entanglement with guidance wires, the potential for any harm or harassment to these species is extremely low. *Therefore, there will be no significant impact to marine mammals resulting from interactions with torpedo guidance wire during AFAST active sonar activities within territorial waters under the No Action Alternative, Alternative 1, Alternative 2, or Alternative 3*. In addition, there will be no significant harm to marine mammals resulting from interactions with torpedo guidance wire during AFAST active sonar activities in non-territorial waters under the No Action Alternative, Alternative 1, Alternative 2, or Alternative 3. The torpedo guidance wires associated with AFAST active sonar activities will have no effect on ESA-listed marine mammal species.

4.4.12.2.3 Torpedo Flex Hoses

Improved flex hoses or strong flex hoses will be expended during torpedo exercises. DON (1996) analyzed the potential for the flex hoses to affect marine mammals. This analysis concluded that the potential entanglement effects to marine animals will be insignificant for reasons similar to those stated for the potential entanglement effects of control wires:

- Due to its weight, the flex hoses will rapidly sink to the bottom upon release. With the exception of a chance encounter with the flex hose while it was sinking to the sea floor, a marine animal would be vulnerable to entanglement only if its diving and feeding patterns placed it in contact with the bottom.
- Due to its stiffness, the 76.2 m (250 ft) long flex hose will not form loops that could entangle marine animals.

Therefore, there will be no significant impact to marine mammals resulting from interactions with torpedo flex hoses during AFAST active sonar activities within territorial waters under the No Action Alternative, Alternative 1, Alternative 2, or Alternative 3. In addition, there will be no significant harm to marine mammals resulting from interactions with torpedo flex hoses during AFAST active sonar activities in non-territorial waters under the No Action Alternative, Alternative 1, Alternative 2, or Alternative 3. The torpedo flex hoses associated with AFAST active sonar activities will have no effect on ESA-listed marine mammal species.

4.4.12.3 Direct Strikes

The Navy uses EMATTs, MK-30 acoustic training targets (recovered), sonobuoys, and exercise torpedoes (MK-46, MK-54, and MK-48) during ASW sonar training exercises. As discussed earlier, MK-54 torpedoes are 271 cm (9 ft) in length and 32 cm (13 in) in diameter (MK-48 torpedoes are half the size of a MK-54 torpedo); MK-48 torpedoes are 580 cm (19 ft) in length and 53 cm (21 in) in diameter (MK-30 targets are similar in size to MK-48 torpedoes; and sonobuoys are 12 by 91 cm (5 by 36 in) (EMATTs are similar in size to a sonobuoy).

The size of these components coupled with the low probability that an animal would occur at the immediate location of deployment and reconnaissance, provide little potential for a direct strike. Moreover, there is a negligible risk that a marine mammal could be struck by a torpedo during ASW training activities. This conclusion is based on (1) review of torpedo design features, and (2) review of a large number of previous naval exercise ASW torpedo activities. The acoustic homing programs of torpedoes are designed to detect either the mechanical sound signature of the submarine or active sonar returns from its metal hull with large, internal air volume interface. Their homing logic does not detect or recognize the relatively small air volume associated with the lungs of marine mammals. Furthermore, the Navy has conducted exercise torpedo activities since 1968 and there have been no recorded or reported instances of a marine species strike by an exercise torpedo during the 14,322 exercise torpedo runs. After each torpedo run, the recovered exercise torpedo is thoroughly inspected for any damage. The torpedoes then go through an extensive production line refurbishment process for re-use. This production line has stringent quality control procedures to ensure that the torpedo will safely and effectively operate during its next run. Since these exercise torpedoes are frequently used against manned Navy submarines, this post activity inspection process is thorough and accurate. Inspection records and quality control documents are prepared for each torpedo run. This post exercise inspection is the basis that supports the conclusion of negligible risk of marine mammal strike.

Therefore, there will be no significant impact to marine mammals resulting from interactions with targets, sonobuoys or exercise torpedoes during AFAST active sonar activities within territorial waters under the No Action Alternative, Alternative 1, Alternative 2, or Alternative 3. In addition, there will be no significant harm to marine mammals resulting from interactions with targets, sonobuoys, or exercise torpedoes during AFAST active sonar activities in non-territorial waters under the No Action Alternative, Alternative 1, Alternative 2, or Alternative 3. The probability of direct strike of training target associated with AFAST training is negligible and therefore will have no effect on ESA-listed marine mammal species.

4.4.13 Potential for Mortality: Cetacean Stranding Activities

The history of Navy activities in the AFAST Study Area and analysis in this document indicate that military readiness activities are not expected to result in any sonar-induced mortalities to marine mammals. There are natural and manmade sources of mortality other than sonar and underwater detonation that may contribute to stranding events as discussed in Section 3.6.3 and described in detail in Appendix E, Cetacean Stranding Report. The actual cause of a particular stranding may not be immediately apparent when there is little evidence of physical trauma, especially in the case of disease or age-related mortalities. These events require careful scientific investigation by a collaborative team of subject matter experts to determine actual cause of death.

Given the frequency of naturally occurring marine mammal strandings (e.g., natural mortality), it is conceivable that a stranding could co-occur with a Navy exercise even though the stranding is actually unrelated to and not caused by Navy activities.

Evidence from five beaked whale strandings that have occurred over approximately a decade, suggests that the exposure of beaked whales to mid-frequency sonar in the presence of certain conditions (e.g., multiple units using tactical sonar, steep bathymetry, constricted channels, strong surface ducts, etc.) may result in strandings, potentially leading to mortality. Although these physical factors believed to contribute to the likelihood of beaked whale strandings are not present, in their aggregate, in the AFAST Study Area, scientific uncertainty exists regarding what other factors, or combination of factors, may contribute to beaked whale strandings.

In a letter from NMFS to Navy dated October 2006, NMFS indicated that Section 101(a)(5)(A) authorization is appropriate for mid-frequency active sonar activities because it allows NMFS to consider the potential for incidental mortality. NMFS' letter indicated; "because mid-frequency sonar has been implicated in several marine mammal stranding events including some involving serious injury and mortality, and because there is no scientific consensus regarding the causal link between sonar and stranding events, NMFS cannot conclude with certainty the degree to which mitigation measures would eliminate or reduce the potential for serious injury of mortality." Accordingly, the Navy is requesting 10 serious injury or mortality takes per year for beaked whale species. This approach overestimates the potential effects to marine mammals associated with Navy sonar training in the AFAST Study Area, as no mortality or serious injury of any species is anticipated. This request will be made even though almost 40 years of conducting similar exercises without incident in the operating environments represented in the AFAST Study Area indicate that injury, strandings, and mortality are not expected to occur as a result of Navy activities. .

Neither NMFS nor the Navy anticipates that marine mammal strandings or mortality will result from the operation of mid-frequency sonar during Navy exercises within the AFAST Study Area. Additionally, through the MMPA process (which allows for adaptive management), NMFS and the Navy will determine the appropriate way to proceed in the unlikely event that a causal relationship were to be found between Navy activities and a future stranding.

4.4.14 Comparison of Potential Marine Mammal Effects by Alternative

The acoustic analysis model is good at producing rough estimates of marine species physiological and behavioral effects, but should not be relied upon solely as a final assessment of the effects to marine mammals. A qualitative analysis of oceanographic and habitat conditions is also an important consideration in the overall marine mammal analysis. Oceanographic features and conditions often determine primary productivity, which drives prey availability and therefore the distribution of marine mammals.

When querying the data from the marine mammal density and acoustic footprint databases, large buffer areas around the training areas are applied. This can hide small geographic differences between the alternatives within the model (e.g. Alternative 3 versus the No Action Alternative) that still may provide significant environmental differences.

Additionally, marine species density models are based on the best available science, but are often compiled from small datasets and are only as good as the limited survey information used to build the models. Single “hotspots” in the density databases can be an artifact of a single data point, and can drive the density estimate for an entire area beyond what is probable or realistic.

Quantitative analysis alone should not be relied upon for a complete assessment of the alternatives presented in this EIS, although the quantitative acoustic analysis can help to inform the decision making process.

Table 4-29. Summary of Acoustic Exposure Estimates by Alternative

Alternative	Effect	
	Level A Harassment	Level B Harassment
Alternative 1	87	1,334,912
Alternative 2	90	1,371,209
Alternative 3	106	1,702,679
No Action Alternative	124	1,911,195

Alternatives 1 and 2 are both geographically bounded for most AFAST active sonar activities and therefore have similar numbers of predicted exposures. The predicted acoustic effects for Alternatives 1 and 2 are significantly less overall than those for the No Action Alternative. Specifically, predicted acoustic exposures, both physiological and behavioral, were significantly less for the following species: Atlantic spotted dolphins, Atlantic white-sided dolphins, bottlenose dolphins, Clymene dolphins, pilot whales, Risso’s dolphins, sperm whales, spinner dolphins, beaked whales, harbor porpoises, fin whales, humpback whales, minke whales, North Atlantic right whales, sei whales, harbor seals, and gray seals. This is because ASW training areas were purposely selected to avoid areas of the highest predicted densities of certain animals and the locations of training boxes avoided some exposures to near-shore species. Spotted dolphins, pantropical spotted dolphins, and striped dolphins all had higher predicted acoustic effects for Alternatives 1 and 2 than for the No Action Alternative. This is because shifting AFAST active sonar activities out of one area with high predicted densities of some species means shifting activities into areas that may have higher densities of other species. Overall however, some of the species avoided in Alternatives 1 and 2, such as beaked whales, are probably more sensitive to noise from AFAST active sonar activities than species where predicted acoustic effects increased.

Comparing Alternatives 1 and 2 is informative because it shows whether or not seasonally shifting AFAST training areas results in lowering predicted acoustic effects. Counter to intuition, notable differences occur which lead to Alternative 2, the seasonally adjusted alternative, to have slightly more predicted acoustic effects overall than Alternative 1. Specifically, Alternative 2 has notable increases over Alternative 1 in exposure estimates to bottlenose dolphins, pantropical spotted dolphins, Atlantic spotted dolphins, Risso's dolphins, as well as a slight increase in the predicted number of acoustic effects to humpback whales. However, under Alternative 2 there are slightly less predicted acoustic effects to potentially sensitive deep diving species (e.g., sperm whales and beaked whales) than under Alternative 1. This is because the seasonal shifts in AFAST training areas were based on a few sensitive species, specifically beaked whales, the sperm whale, and the North Atlantic right whale. Seasonally shifting areas based on these species concentrates activities in areas that contain higher predicted densities of other species.

Alternative 3 designates areas of increased awareness where AFAST active sonar activities would not normally occur. The methodology used to select these areas of increased awareness differed from the methods used to designate the AFAST training areas in Alternatives 1 and 2. Areas for Alternatives 1 and 2 were picked based on avoiding high predicted densities of most species. It is these predicted densities of marine mammals that were used as inputs into the quantitative acoustic analysis which produces an inherent model bias. Alternative 3 used oceanographic and bathymetric features (e.g. steep shelf breaks, canyons, and notable features of the Gulf Stream) that are known to be areas of high primary productivity and therefore likely attract and concentrate marine species. Therefore caution should be exercised when comparing the results of the quantitative acoustic analysis, as there are considerable qualitative factors to consider.

Alternative 3, as compared to the No Action Alternative, has a decrease in acoustic effects to ESA-listed marine mammals, beaked whales, bottlenose dolphins, Atlantic spotted dolphins, and striped dolphins. The most notable increase in the predicted acoustic effects in Alternative 3 is to harbor porpoises, Atlantic white-sided dolphins, and harbor seals in Alternative 3. The main reason why the overall exposure estimates for Alternative 3 are less than the No Action Alternative is the exclusion of active sonar activities within areas of notable oceanographic and bathymetric features that typically indicate higher concentrations of marine species.

There was no appreciable difference between alternatives for ingestion of or entanglement in expended materials by marine mammals. Likewise there was no appreciable difference between alternatives for vessel strikes to marine mammals.

4.5 SEA TURTLES

This section evaluates potential direct and indirect effects on sea turtles as a result of exposure to mid-frequency (1 to 10 kHz) and high-frequency (greater than 10 kHz) active sonar, and the explosive source sonobuoy (AN/SSQ-110). Six species of sea turtles (Atlantic loggerhead, Atlantic green, leatherback, hawksbill, olive ridley and Kemp's ridley) occur in the Gulf of Mexico and North Atlantic. All species but the loggerhead are classified as endangered. The loggerhead is classified as threatened. Refer to Chapter 3.7 for a more detailed description on the occurrence of sea turtle species within the North Atlantic and Gulf of Mexico.

The primary issue of concern is the potential for sonar and other sound to affect marine species, including sea turtles. Sea turtles do not have an auditory meatus or pinna that channels sound to the middle ear, nor do they have a specialized tympanum (eardrum). Instead, they have a cutaneous layer and underlying subcutaneous fatty layer that function like a tympanic membrane. The subcutaneous fatty layer receives and transmits sound to the extracolumella, a cartilaginous disk, located at the columella, a long, thin bone that extends from the middle ear cavity to the entrance of the inner ear or otic cavity (Ridgway et al., 1969b). Sound arriving at the inner ear via the columella is transduced by the bones of the middle ear. Sound also arrives by bone conduction through the skull.

In contrast to marine mammals, little is known about the role of sound and hearing in sea turtle survival and only rudimentary information is available about responses to anthropogenic noise. Sea turtles appear to be most sensitive to low frequencies; greatest sensitivities are 300 to 400 Hz for the green turtle (Ridgway et al., 1969b) and around 250 Hz for juvenile loggerheads (Bartol et al., 1999). The effective hearing range for marine turtles is generally considered to be between 100 and 1000 Hz (Bartol et al., 1999; Lenhardt, 1994; Moein, 1994; Ridgway et al., 1969b). Hearing thresholds below 100 Hz were found to increase rapidly (Lenhardt, 1994). Additionally, calculated in-water hearing thresholds at best frequencies (100 to 1000 Hz) appear to be high—160 to 200 dB re 1μPa (Lenhardt, 1994; Moein et al., 1995).

Sea turtle auditory capabilities and sensitivity are not well-studied, although a few investigations suggest that it sea turtle hearing is limited to lower frequencies, such as the sounds of waves breaking on a beach. The role of underwater low-frequency hearing in sea turtles is unclear. It has been suggested that sea turtles may use acoustic signals from their environment as guideposts during migration and as cues to identify their natal beaches (Lenhardt et al., 1983). Ridgway et al. (1969) used aerial and mechanical stimulation to measure the cochlea in three specimens of green turtle, and concluded that they have a useful hearing span of perhaps 60 to 1,000 Hz, but hear best from about 200 Hz up to 700 Hz, with their sensitivity falling off considerably below 200 Hz. The maximum sensitivity for one animal was at 300 Hz, and for another was at 400 Hz. At the 400 Hz frequency, the turtle's hearing threshold was about 64 dB in air. At 70 Hz, it was about 70 dB in air. These values probably apply to all four of the hard-shell turtles (i.e., the green, loggerhead, hawksbill, and Kemp's ridley turtles). No audiometric data are available for the leatherback sea turtle, but based on other sea turtle hearing capabilities, they probably also hear best in the low frequencies.

Lenhardt et al. (1983) also applied audio-frequency vibrations at 250 Hz and 500 Hz to the heads of loggerheads and Kemp's ridleys submerged in salt water to observe their behavior, measure the attenuation of the vibrations, and assess any neural-evoked response. These stimuli were chosen as representative of the lowest sensitivity area of marine turtle hearing (Wever, 1978). At the maximum upper limit of the vibratory delivery system, the turtles exhibited abrupt movements, slight retraction of the head, and extension of the limbs in the process of swimming. Lenhardt et al. (1983) concluded that bone-conducted hearing appears to be a reception mechanism for at least some of the sea turtle species, with the skull and shell acting as receiving surfaces.

A recent study on the effects of airguns on sea turtle behavior also suggests that sea turtles are most likely to respond to low-frequency sounds (McCauley et al., 2000). The pressure level is measured at a standard reference point such as 1 meter with a reference pressure of 1 μPa (i.e., re 1 μPa). Green and loggerhead sea turtles exposed to seismic air guns began to noticeably increase their swimming speed, as well swimming direction, when received levels reached 166 dB re 1 μPa, and their behavior became increasingly erratic at 175 dB re 1 μPa (McCauley et al., 2000).

Extrapolation from human and marine mammal data to turtles may be inappropriate given the morphological differences between the auditory systems of mammals and turtles. Currently it is believed that the range of maximum sensitivity for sea turtles is 0.1 to 0.8 kHz, with an upper limit of about 2.0 kHz (Lenhardt, 1994). Hearing below 0.08 kHz is less sensitive but still potentially usable to the animal. Green turtles are most sensitive to sounds between 0.2 and 0.7 kHz, with peak sensitivity at 0.3 to 0.4 kHz (Ridgway et al., 1997). They possess an overall hearing range of approximately 0.1 to 1.0 kHz (Ridgway et al., 1969b). Juvenile loggerhead turtles hear sounds between 0.25 and 1.0 kHz and, therefore, often avoid these low frequency sounds (Bartol et al., 1999). Finally, sensitivity even within the optimal hearing range is apparently low-threshold detection levels in water are relatively high at 160 to 200 dB re 1 μPa (Lenhardt, 1994). Given the lack of audiometric information, the potential for temporary threshold shifts among leatherback turtles must be classified as unknown but would likely follow those of other sea turtles. In terms of sound emission, nesting leatherback turtles produce sounds in the 0.3 to 0.5 kHz range (Mrosovsky, 1972).

4.5.1 Mid-Frequency and High-Frequency Active Sonar

Any potential role of long-range acoustical perception in sea turtles has not been studied and is unclear at this time. The concept of sound masking is difficult, if not impossible, to apply to sea turtles. Although mid-frequency hearing has not been studied in many sea turtle species, most of those that have been tested exhibit low audiometric and behavioral sensitivity to low-frequency sound. It appears that if there were the potential for the mid-frequency sonar to increase masking effects for any sea turtle species, it would be expected to be minimal.

Additionally, although little data exist on sea turtle hearing and past studies are limited, sea turtle navigation has been relatively well studied. Unlike marine mammals, researchers have found that sea turtles use non-acoustic cues in migration and particularly in movement related to hatchling activity, nesting, and long-distance migrations. Hatchlings can use magnetic fields to navigate (Lohmann, 1991; Lohmann and Lohmann, 1996). Recent studies have found that they supplement this navigation technique with a secondary method based on the sun or skylight (Avens and Lohman, 2003). Recent studies focused on juvenile and adult navigation. Avens and Lohmann (2004) concluded from their survey that juvenile and adult sea turtles have a map-based navigation capability (or they are able to home to specific locations). Sea turtles of these age classes may use other indicators such as chemical cues and magnetic fields to navigate to specific areas (Avens and Lohmann, 2004). Since sea turtles rely on multiple sensory systems to navigate and because the sonar systems used during AFAST active sonar activities are at frequency ranges higher than the optimal hearing capabilities of sea turtles, mid- and high-frequency active sonar would not affect sea turtle navigation.

Therefore, there will be no significant impact to sea turtles from active sonar activities in territorial waters under the No Action Alternative, Alternative 1, Alternative 2, or Alternative 3. In addition, there will be no significant harm to sea turtles from active sonar activities in non-territorial waters under the No Action Alternative, Alternative 1, Alternative 2, or Alternative 3.

In accordance with the ESA, the Navy finds the AFAST active sonar activities will have no effect on ESA-listed sea turtle species.

4.5.2 Explosive Source Sonobuoy (AN/SSQ-110A)

Adult loggerheads have been observed to initially respond (i.e., increase swimming speeds) and avoid air guns when received levels range from 151 to 175 dB re 1 μPa, but they eventually habituate to these sounds (Lenhardt, 2002). In one study, one turtle did exhibit TTS for up to two weeks after exposure to these levels (Lenhardt, 2002). Juveniles also have been found to avoid low-frequency sound (less than 1,000 Hz) produced by air guns (O'Hara and Wilcox, 1990). In a separate study, green and loggerhead sea turtles exposed to seismic air guns began to noticeably increase their swimming speed, as well swimming direction, when received levels reached 166 dB re 1 μPa, and their behavior became increasingly erratic at 175 dB re 1 μPa (McCauley et al., 2000). Although, auditory data have never been collected for the leatherback turtle, there is an anecdotal observation of this species responding to the sound of a boat motor (ARPA, 1995). However, it is unclear what frequencies of the sound this animal was detecting.

Navy analysts have compared the injury levels reported by widely-accepted experiments to the injury levels that would be predicted using the modified Goertner method (Goertner, 1982). For this assessment, the Level A harassment/injury criteria for marine mammals, as established in the Churchill FEIS (DON, 2001a), is equated to ESA harm for turtles. In addition, the Level B harassment criterion for toothed whales are equated to ESA harassment for sea turtles. Table 4-30 shows the criteria used for sea turtles. Section 4.4.6 provides a more detailed explanation for each criteria level, metric, and threshold for small explosives (i.e., explosive source sonobuoy [AN/SSQ-110A]). The only explosive source analyzed in the AFAST EIS/OEIS is the AN/SSQ-110A IEER sonobuoy. Due to the physical and time spacing of sonobuoy detonations, these detonations are treated as individual explosions with non-overlapping sound fields for the purpose of this analysis.

Table 4-30. Explosive Criteria Used for Estimating Sea Turtle Exposures

Effect	Criteria	Metric	Threshold
Mortality	Onset extensive lung injury	Goertner modified positive impulse	30.5 psi-ms
Physiological	Onset slight lung injury/PTS	Goertner modified positive impulse	indexed to 13 psi-ms
Behavioral	TTS	Greatest energy flux density level in any 1/3-octave band above 100 Hz - for total energy over all exposures	182 dB re 1 μPa^2-s
Behavioral	TTS	Peak pressure over all exposures	23 psi

dB 1 μPa^2-s – decibel referenced to 1 micropascal squared second; Hz – hertz;
MMPA – Marine Mammal Protection Act; psi-ms = pounds per square inch-millisecond;
TM – tympanic membrane; TTS – temporary threshold shift

As shown in Tables 4-31 through 4-34, the analysis identified the potential for all sea turtles to be exposed to sound from AFAST active sonar activities involving the explosive source sonobuoy (AN/SSQ-110A). Exposures numbers were rounded to "1" if the result was equal to or greater than 0.5. Even though an exposure number may have rounded to "0" in an individual analysis area, when summed with all other results for other analysis areas within the AFAST Study Area, an exposure of "1" is possible.

This page is intentionally blank.

Table 4-31. Estimated Sea Turtle Acoustic Exposures from Explosive Source Sonobuoys (AN/SSQ-110A) Under the No Action Alternative

Species	Atlantic Ocean, Offshore of the Southeastern United States									Northeast			Gulf of Mexico		
	VACAPES OPAREA			CHPT OPAREA			JAX/CHASN OPAREA			Northeast OPAREA			GOMEX		
	Mortality	PTS	TTS	Mortality	PTS	TTS	Mortality	PTS	TTS	Mortality	PTS	TTS	Mortality	PTS	TTS
Loggerhead sea turtle	0	0*	1	0	0*	0*	0	0*	1	0	0	0	0	0*	1
Kemp's ridley sea turtle[1]	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Leatherback sea turtle	0	0	0*	0	0	0	0	0	0	0	0	0	0	0	0*
Hardshell sea turtles[2]	0	0*	0*	0	0	0*	0	0*	0*	0	0	0	0	0*	1

*Indicates an exposure greater than or equal to 0.05, therefore is considered a "may affect" for ESA listed species.
1. This category does not include Kemp's ridley sea turtles in the Gulf of Mexico. They are included in the hardshell sea turtle class.
2. This category includes green, hawksbill, and unidentified hardshell species for all regions. It also includes Kemp's ridley sea turtles in the Gulf of Mexico, and may include extralimital occurrences of olive ridley turtles along the Atlantic coast.

Table 4-32. Estimated Sea Turtle Acoustic Exposures from Explosive Source Sonobuoys (AN/SSQ-110A) Under Alternative 1

Species	Atlantic Ocean, Offshore of the Southeastern United States									Northeast			Gulf of Mexico		
	VACAPES OPAREA			CHPT OPAREA			JAX/CHASN OPAREA			Northeast OPAREA			GOMEX		
	Mortality	PTS	TTS	Mortality	PTS	TTS	Mortality	PTS	TTS	Mortality	PTS	TTS	Mortality	PTS	TTS
Loggerhead sea turtle	0	0*	1	0	0*	0*	0*	1	3	0	0	0*	0	0*	1
Kemp's ridley sea turtle[1]	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Leatherback sea turtle	0	0	0	0	0	0	0*	1	3	0	0	0	0	0	0*
Hardshell sea turtles[2]	0	0*	0*	0	0	0*	0	0*	2	0	0*	0*	0	0*	1

*Indicates an exposure greater than or equal to 0.05, therefore is considered a "may affect" for ESA listed species.
1. This category does not include Kemp's ridley sea turtles in the Gulf of Mexico. They are included in the hardshell sea turtle class.
2. This category includes green, hawksbill, and unidentified hardshell species for all regions. It also includes Kemp's ridley sea turtles in the Gulf of Mexico, and may include extralimital occurrences of olive ridley turtles along the Atlantic coast.

Table 4-33. Estimated Sea Turtle Acoustic Exposures from Explosive Source Sonobuoys (AN/SSQ-110A) Under Alternative 2

Species	Atlantic Ocean, Offshore of the Southeastern United States									Northeast			Gulf of Mexico		
	VACAPES OPAREA			CHPT OPAREA			JAX/CHASN OPAREA			Northeast OPAREA			GOMEX		
	Mortality	PTS	TTS	Mortality	PTS	TTS	Mortality	PTS	TTS	Mortality	PTS	TTS	Mortality	PTS	TTS
Loggerhead sea turtle	0	0*	1	0	0*	0*	0	1	2	0	0	0*	0	0*	1
Kemp's ridley sea turtle[1]	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Leatherback sea turtle	0	0	0	0	0	0	0	0*	1	0	0	0	0	0	0*
Hardshell sea turtles[2]	0	0*	0*	0	0	0*	0	0*	2	0	0*	0*	0	0*	1

*Indicates an exposure greater than or equal to 0.05, therefore is considered a "may affect" for ESA listed species.
1. This category does not include Kemp's ridley sea turtles in the Gulf of Mexico. They are included in the hardshell sea turtle class.
2. This category includes green, hawksbill, and unidentified hardshell species for all regions. It also includes Kemp's ridley sea turtles in the Gulf of Mexico, and may include extralimital occurrences of olive ridley turtles along the Atlantic coast.

Table 4-34. Estimated Sea Turtle Acoustic Exposures from Explosive Source Sonobuoys (AN/SSQ-110A) Under Alternative 3

Species	Atlantic Ocean, Offshore of the Southeastern United States									Northeast			Gulf of Mexico		
	VACAPES OPAREA			CHPT OPAREA			JAX/CHASN OPAREA			Northeast OPAREA			GOMEX		
	Mortality	PTS	TTS	Mortality	PTS	TTS	Mortality	PTS	TTS	Mortality	PTS	TTS	Mortality	PTS	TTS
Loggerhead sea turtle	0	0*	1	0	0*	0*	0	0*	1	0	0	0	0	0*	1
Kemp's ridley sea turtle[1]	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Leatherback sea turtle	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0*
Hardshell sea turtles[2]	0	0*	1	0	0	0*	0	0*	0*	0	0	0	0	0*	1

*Indicates an exposure greater than or equal to 0.05, therefore is considered a "may affect" for ESA listed species.
1. This category does not include Kemp's ridley sea turtles in the Gulf of Mexico. They are included in the hardshell sea turtle class.
2. This category includes green, hawksbill, and unidentified hardshell species for all regions. It also includes Kemp's ridley sea turtles in the Gulf of Mexico, and may include extralimital occurrences of olive ridley turtles along the Atlantic coast.

4.5.2.1 Loggerhead Sea Turtles

Acoustic analysis indicates that up to three loggerhead sea turtles may be exposed to levels of sound from explosive source sonobuoys likely to result in TTS under the No Action Alternative, five under Alternative 1, four under Alternative 2, and three under Alternative 3. The exposure estimates for each alternative represents the total number of exposures and not necessarily the number of individuals exposed, as a single individual may be exposed multiple times over the course of a year. Acoustic analysis indicates that zero loggerhead sea turtles may be exposed to levels of sound from explosive source sonobuoys likely to result in PTS or onset slight lung injury under the No Action Alternative, one under Alternative 1, one under Alternative 2, and zero under Alternative 3. The exposure numbers for PTS under all Alternatives include no possible mortalities. The above numbers represent potential exposures based on modeling results specifically for loggerhead sea turtles. However, additional loggerhead turtles could be included in the hardshell sea turtle class of Tables 4-31 through 4-34, which includes unidentified hardshell turtles. Therefore, the total number of loggerheads harassed could be greater than the numbers identified above. Modeling of the explosive source sonobuoys predicts no mortality to loggerhead sea turtles.

Even though loggerhead sea turtles may exhibit a reaction when initially exposed to impulsive acoustic energy, the effects will not be long-term, and any such exposures are not expected to result in significant effects to individual loggerhead sea turtles or to the population. The mitigations presented in Chapter 5 will further reduce the potential for exposures to occur to individual loggerhead sea turtles.

In accordance with NEPA, there will be no significant impact to loggerhead sea turtles from AFAST active sonar activities in territorial waters under the No Action Alternative, Alternative 1, Alternative 2, or Alternative 3. Further, in accordance with EO 12114, there will be no significant harm to loggerhead sea turtles from AFAST active sonar activities in non-territorial waters under the No Action Alternative, Alternative 1, Alternative 2, or Alternative 3.

In accordance with the ESA, the Navy finds the AFAST active sonar activities may affect loggerhead sea turtles. The Navy initiated consultation with NMFS in accordance with Section 7 of the ESA.

4.5.2.2 Kemp's Ridley Sea Turtles

In the Atlantic Ocean, acoustic analysis indicates that no Kemp's ridley sea turtles will be exposed to levels of sound from explosive source sonobuoys likely to result in TTS under the No Action Alternative, Alternative 1, Alternative 2, or Alternative 3. Acoustic analysis indicates that no Kemp's ridley sea turtles will be exposed to levels of sound from explosive source sonobuoys likely to result in PTS or onset slight lung injury under the No Action Alternative, Alternative 1, Alternative 2, or Alternative 3. The above numbers represent potential exposures based on modeling results specifically for Kemp's ridley sea turtles in the Atlantic Ocean. However, additional Kemp's ridley turtles could be included in the hardshell sea turtle class of Tables 4-31 through 4-34, which includes unidentified hardshell turtles. Therefore, the total number of Kemp's ridleys harassed in the Atlantic could be greater than the numbers identified above.

In the Gulf of Mexico, acoustic modeling results are not available specifically for Kemp's ridley sea turtles because the number of sightings for this species was not sufficient to allow for spatial modeling. However, this species comprises an unknown portion of the unidentified hardshell sea turtle class for the GOMEX in Tables 4-30 through 4-33. Acoustic analysis indicates the potential for exposure of hardshell turtles (including Kemp's ridley sea turtles) to levels of sound from explosive source sonobuoys likely to result in TTS and PTS or onset slight lung injury. The exposure estimates for each alternative represent the total number of exposures and not necessarily the number of individuals exposed, as a single individual may be exposed multiple times over the course of a year. Modeling of the explosive source sonobuoys predicts no mortality to hardshell turtles, and thus no mortality to the Kemp's ridley sea turtles in the Gulf of Mexico.

Even though Kemp's ridley sea turtles may exhibit a reaction when initially exposed to impulsive acoustic energy, the effects will not be long-term, and any such exposures are not expected to result in significant effects to individual Kemp's ridley sea turtles or to the population. The mitigations presented in Chapter 5 will further reduce the potential for exposures to occur to individual Kemp's ridley sea turtles.

In accordance with NEPA, there will be no significant impact to Kemp's ridley sea turtles from AFAST active sonar activities in territorial waters under the No Action Alternative, Alternative 1, Alternative 2, or Alternative 3. Further, in accordance with EO 12114, there will be no significant harm to Kemp's ridley sea turtles from AFAST active sonar activities in non-territorial waters under the No Action Alternative, Alternative 1, Alternative 2, or Alternative 3.

In accordance with the ESA, the Navy finds the AFAST active sonar activities may affect Kemp's ridley sea turtles. The Navy initiated consultation with NMFS in accordance with Section 7 of the ESA for concurrence.

4.5.2.3 Leatherback Sea Turtles

Acoustic analysis indicates that no leatherback sea turtles may be exposed to levels of sound from explosive source sonobuoys likely to result in TTS under the No Action Alternative, four under Alternative 1, one under Alternative 2, and none under Alternative 3. The exposure estimates for each alternative represents the total number of exposures and not necessarily the number of individuals exposed, as a single individual may be exposed multiple times over the course of a year. Acoustic analysis indicates that no leatherback sea turtles may be exposed to levels of sound from explosive source sonobuoys likely to result in PTS or onset slight lung injury under the No Action Alternative, one under Alternative 1, none under Alternative 2, and none under Alternative 3. The exposure numbers for PTS under all Alternatives includes no possible mortalities.

Even though leatherback sea turtles may exhibit a reaction when initially exposed to impulsive acoustic energy, the effects will not be long-term, and any such exposures are not expected to result in significant effects to individual leatherback sea turtles or to the population. The mitigations presented in Chapter 5 will further reduce the potential for exposures to occur to individual leatherback sea turtles.

In accordance with NEPA, there will be no significant impact to leatherback sea turtles from AFAST active sonar activities in territorial waters under the No Action Alternative, Alternative 1, Alternative 2, or Alternative 3. Further, in accordance with EO 12114, there will be no significant harm to leatherback sea turtles from AFAST active sonar activities in non-territorial waters under the No Action Alternative, Alternative 1, Alternative 2, or Alternative 3.

In accordance with the ESA, the Navy finds the AFAST active sonar activities may affect leatherback sea turtles. The Navy initiated consultation with NMFS in accordance with Section 7 of the ESA for concurrence.

4.5.2.4 Atlantic Green Sea Turtles

Acoustic modeling results are not available specifically for Atlantic green sea turtles because the numbers of sightings for this species were not sufficient to allow for spatial modeling. However, this species comprises an unknown portion of the unidentified hardshell sea turtle class in Tables 4-31 through 4-34. Acoustic analysis indicates the potential for exposure of hardshell turtles (including green sea turtles) to levels of sound from explosive source sonobuoys likely to result in TTS and PTS or onset slight lung injury. The exposure estimates for each alternative represent the total number of exposures and not necessarily the number of individuals exposed, as a single individual may be exposed multiple times over the course of a year. Modeling of the explosive source sonobuoys predicts no mortality to hardshell turtles, and thus no mortality to Atlantic green sea turtles.

Even though Atlantic green sea turtles may exhibit a reaction when initially exposed to impulsive acoustic energy, the effects will not be long-term, and any such exposures are not expected to result in significant effects to individual green sea turtles or to the population. The mitigations presented in Chapter 5 will further reduce the potential for exposures to occur to individual green sea turtles.

In accordance with NEPA, there will be no significant impact to Atlantic green sea turtles from AFAST active sonar activities in territorial waters under the No Action Alternative, Alternative 1, Alternative 2, or Alternative 3. Further, in accordance with EO 12114, there will be no significant harm to green turtles from AFAST active sonar activities in non-territorial waters under the No Action Alternative, Alternative 1, Alternative 2, or Alternative 3.
In accordance with the ESA, the Navy finds the AFAST active sonar activities may affect Atlantic green sea turtles. The Navy initiated consultation with NMFS in accordance with Section 7 of the ESA.

4.5.2.5 Hawksbill Sea Turtles

Acoustic modeling results are not available specifically for hawksbill sea turtles because the number of sightings for this species was not sufficient to allow for spatial modeling. However, this species comprises an unknown portion of the unidentified hardshell sea turtle class in Tables 4-31 through 4-34. Acoustic analysis indicates the potential for exposure of hardshell turtles (including hawksbill sea turtles) to levels of sound from explosive source sonobuoys likely to result in TTS and PTS or onset slight lung injury. The exposure estimates for each alternative represent the total number of exposures and not necessarily the number of individuals exposed, as a single individual may be exposed multiple times over the course of a year. Modeling of the explosive source sonobuoys predicts no mortality to hardshell turtles, and thus mortality to hawksbill sea turtles.

Even though hawksbill sea turtles may exhibit a reaction when initially exposed to impulsive acoustic energy, the effects will not be long-term, and any such exposures are not expected to result in significant effects to individual hawksbill turtles or to the population. The mitigations presented in Chapter 5 will further reduce the potential for exposures to occur to individual hawksbill sea turtles.

In accordance with NEPA, there will be no significant impact to hawksbill sea turtles from AFAST active sonar activities in territorial waters under the No Action Alternative, Alternative 1, Alternative 2, or Alternative 3. Further, in accordance with EO 12114, there will be no significant harm to hawksbill sea turtles from AFAST active sonar activities in non-territorial waters under the No Action Alternative, Alternative 1, Alternative 2, or Alternative 3.

In accordance with the ESA, the Navy finds the AFAST active sonar activities may affect hawksbill sea turtles. The Navy initiated consultation with NMFS in accordance with Section 7 of the ESA.

4.5.2.6 Olive Ridley Sea Turtles

Acoustic modeling results are not available specifically for olive ridley sea turtles. Although extremely rare in the North Atlantic Ocean, this species may comprise an unknown portion of the unidentified hardshell sea turtle class in Tables 4-31 through 4-34. Acoustic analysis indicates the potential for exposure of hardshell turtles (including olive ridley sea turtles) to levels of sound likely to result in TTS and PTS or onset slight lung injury. The exposure estimates for each alternative represent the total number of exposures and not necessarily the number of individuals exposed, as a single individual may be exposed multiple times over the course of a year. Modeling of the explosive source sonobuoys predicts no mortality to hardshell turtles, and thus no potential for mortality to olive ridley sea turtles.

Even though olive ridley sea turtles may exhibit a reaction when initially exposed to impulsive acoustic energy, the effects will not be long-term, and any such exposures are not expected to result in significant effects to individuals or to the population. The mitigations presented in Chapter 5 will further reduce the potential for exposures to occur to individual olive ridley sea turtles.

In accordance with NEPA, there will be no significant impact to olive ridley sea turtles from AFAST active sonar activities in territorial waters under the No Action Alternative, Alternative 1, Alternative 2, or Alternative 3. Further, in accordance with EO 12114, there will be no significant harm to olive ridley sea turtles from AFAST active sonar activities in non-territorial waters under the No Action Alternative, Alternative 1, Alternative 2, or Alternative 3.

In accordance with the ESA, the Navy finds the AFAST active sonar activities, due to the extremely low probability of encountering an olive ridley sea turtle will have no effect on olive ridley sea turtles. The Navy initiated consultation with NMFS in accordance with Section 7 of the ESA for concurrence.

4.5.3 Potential Nonacoustic Effects to Sea Turtles

4.5.3.1 Vessel Strikes

Boat strikes are known to affect sea turtles. Turtles swimming or feeding at or just beneath the surface of the water are particularly vulnerable to a vessel strike. According to the Florida Fish and Wildlife Conservation Commission (unpublished data), there has been a significantly increasing trend in the occurrence of propeller wounds among the loggerheads found dead or debilitated each year in Florida during 1986 through 2004.

Accordingly, the U.S. Navy has adopted standard operating procedures and mitigation measures to reduce the potential for collisions with surfaced marine mammals (for more details refer to Chapter 5). These mitigation measures include:

- Using lookouts trained to detect all objects on the surface of the water, including sea turtles.
- Implementing reasonable and prudent actions to avoid the close interaction of Navy assets and sea turtles.
- Maneuvering to keep away from any observed sea turtle.

Additionally, the Navy implements additional mitigation measures to protect North Atlantic right whales which benefit sea turtles. As described in Section 4.4.12.1, the East Coast is a principal migratory corridor for North Atlantic right whales that travel between the calving/nursery areas in the southeast and feeding grounds in the northeast. In 2004, NMFS proposed a right whale vessel collision reduction strategy to consider the establishment of operational measures for the shipping industry to reduce the potential for large vessel collisions with North Atlantic right whales while transiting to and from mid-Atlantic ports during right whale migratory periods. The Navy was the first federal agency to proactively adopt additional protective measures for transits in the vicinity of mid-Atlantic ports during right whale migration, which also benefits sea turtles during this period. Specifically, the Navy has unilaterally adopted the following mitigation measures that benefit sea turtles:

- Navy vessels will practice increased vigilance with respect to avoidance of vessel-whale interactions along the mid-Atlantic coast, including transits to and from any mid-Atlantic ports.
- All surface units transiting within 56 km (30 NM) of the coast in the mid-Atlantic will ensure at least two watchstanders are posted, including at least one lookout who has completed required marine species awareness training.

For purposes of these measures, the mid-Atlantic is defined broadly to include ports south and east of Block Island Sound southward to South Carolina. Based on the implementation of general mitigation measures described above for sea turtles and the implementation of additional mitigation measures during times of anticipated right whale occurrences (refer to Chapter 5 for additional information), the likelihood that a ship strike will occur during AFAST active sonar activities is low. *Therefore, there will be no significant impact to loggerhead, green, leatherback, Kemp's ridley, hawksbill, or olive ridley sea turtles from vessel interactions during AFAST training exercises within territorial waters*. In addition, there will be no significant harm to loggerhead, green, leatherback, Kemp's ridley, hawksbill, or olive ridley sea turtles resulting from vessel interactions during AFAST training exercises in non-territorial waters. AFAST training exercises may affect loggerhead, green, leatherback, Kemp's ridley, and hawksbill sea turtles through vessel-strikes.

4.5.3.2 Expended Materials

Similar to marine mammals, sea turtles are subject to entanglement in expended materials, particularly anything incorporating loops or rings, hooks and lines, or sharp objects. Data collected from the Sea Turtle Stranding and Salvage Network from 1980 through 1992 documented 22,547 turtles stranded throughout the U.S. Atlantic and Gulf of Mexico coasts, Puerto Rico, and the U.S. Virgin Islands (Witzell and Teas, 1994). Of these stranded animals, 416 were affected by entanglement, which includes 182 (44 percent) turtles by fish hooks and/or monofilament fishing lines, 74 (18 percent) turtles by fish net material, 114 (27 percent) turtles by commercial crab and lobster trap lines, and 46 (11 percent) turtles by non-fishing items. Non-fishing items included plastic fiber sacks, burlap sacks, plastic bags, six-pack yokes, packing twine, steel cable, and aluminum beach chairs (Witzel and Teas, 1994). Thus, most entanglements appear to be attributed to fishing materials. Possible expended materials from AFAST active sonar activities includes sonobuoys, torpedoes, and ADCs, and EMATTs (Table 4-1). Specifically, during torpedo exercises, guidance wires and flex hoses are expended. Moreover, sonobuoy parachutes, lines, and drogues, as well as EMATT parachutes are also expended during AFAST active sonar activities. This section analyzes the potential effects of expended materials on sea turtles.

4.5.3.2.1 Parachutes

Aircraft-launched sonobuoys, torpedoes, and EMATTs deploy nylon parachutes of varying sizes. At water impact, the parachute assembly is expended, and it sinks away from the exercise sonobuoy or torpedo. The parachute assembly will potentially be at the surface for a short time before sinking to the sea floor. Entanglement and the eventual drowning of a sea turtle in a parachute assembly will be unlikely, since the parachute will have to land directly on an animal, or an animal will have to swim into it before it sinks. The potential for a sea turtle to encounter an expended parachute is extremely low, given the generally low probability of a sea turtle being in the immediate location of deployment, especially given the mitigation measures outlined in Chapter 5.

All of the material is negatively buoyant and will sink to the ocean floor. Many of the components are metallic and will sink rapidly. The expended material will accumulate on the ocean floor and will be covered by sediments over time, thereby remaining on the ocean floor, reducing the potential for entanglement. This accrual of material is not expected to cause an increased potential for sea turtle entanglement since the items will be in a portion of the deep water column that sea turtles inhabit for a limited amount of time. If bottom currents are present, the canopy may billow (bulge) and pose an entanglement threat to marine animals with bottom-feeding habits; however, billowing is less likely to occur in deeper waters were bottom currents are negligible. the probability of a sea turtle encountering a parachute assembly and the potential for accidental entanglement in the canopy or suspension lines is considered to be unlikely.

The overall possibility of sea turtles ingesting parachute fabric or becoming entangled in cable assemblies is very remote. *Therefore, there will be no significant impact to sea turtles resulting from interactions with parachute assemblies during AFAST active sonar activities within territorial waters under the No Action Alternative, Alternative 1, Alternative 2, or Alternative 3*. In addition, there will be no significant harm to sea turtles resulting from interactions with parachute assemblies during AFAST active sonar activities in non-territorial waters under the No Action Alternative, Alternative 1, Alternative 2, or Alternative 3. AFAST training activities with respect to parachute assemblies may affect ESA-listed sea turtles. Parachutes associated with AFAST training may affect ESA-listed sea turtle species.

4.5.3.2.2 Torpedoes

There is a negligible risk that a sea turtle could be struck by a torpedo during ASW training activities. This conclusion is based on (1) review of torpedo design features and (2) review of a large number of previous naval exercise ASW torpedo activities.

The acoustic homing programs of torpedoes are designed to detect either the mechanical sound signature of the submarine or active sonar returns from its metal hull with large internal air volume interface. The torpedoes are specifically designed to ignore false targets. As a result, their homing logic does not detect or recognize the relatively small air volume associated with the lungs of sea turtles. They do not detect or home to sea turtles.

The Navy has conducted exercise torpedo activities since 1968. At least 14,322 exercise torpedo runs have been conducted since 1968. There have been no recorded or reported instances of a marine species strike by an exercise torpedo. Every exercise torpedo activity is monitored acoustically by on-scene range personnel listening to range hydrophones positioned on the ocean floor in the immediate vicinity of the torpedo activity. After each torpedo run, the recovered exercise torpedo is thoroughly inspected for any damage. The torpedoes then go through an extensive production line refurbishment process for re-use. This production line has stringent quality control procedures to ensure that the torpedo will safely and effectively operate during its next run. Since these exercise torpedoes are frequently used against manned Navy submarines, this post-activity inspection process is thorough and accurate. Inspection records and quality control documents are prepared for each torpedo run. This post exercise inspection is the basis that supports the conclusion of negligible risk of sea turtle strike. *Therefore, there will be no significant impact to sea turtles resulting from interactions with torpedoes during AFAST active sonar activities within territorial waters under the No Action Alternative, Alternative 1, Alternative 2, or Alternative 3*. In addition, there will be no significant harm to sea turtles resulting from interactions with torpedoes during AFAST active sonar activities in non-territorial waters under the No Action Alternative, Alternative 1, Alternative 2, or Alternative 3. The probability of direct strike of torpedoes associated with AFAST training is negligible and therefore will have no effect on ESA-listed sea turtle species.

4.5.3.2.3 Torpedo Guidance Wires

Torpedoes are equipped with a single-strand guidance wire, which is laid behind the torpedo as it moves through the water. At the end of a torpedo run, the wire is released from the firing vessel and the torpedo to enable torpedo recovery. The wire sinks rapidly and settles on the ocean floor. Guidance wires are expended with each exercise torpedo launched. Each year, about 254 exercise torpedoes will be used; therefore, the same number of control wires will be expended annually.

DON (1996) analyzed the potential entanglement effects of torpedo control wires on sea turtles. The Navy analysis concluded that the potential for entanglement effects will be low for the following reasons:

- The guidance wire is a very fine, thin-gauge copper-cadmium core with a polyolefin coating. The tensile breaking strength of the wire is a maximum of 19 kg (42 lb) and can be broken by hand. With the exception of a change encounter with the guidance wire while it was sinking to the sea floor (at an estimate rate of 0.2 m [0.5 ft] per second), a sea turtle would be vulnerable to entanglement only if its diving and feeding patterns place it in contact with the bottom.
- The torpedo control wire is held stationary in the water column by drag forces as it is pulled from the torpedo in a relatively straight line until its length becomes sufficient for it to form a chain-like droop. When the wire is cut or broken, it is relatively straight and the physical characteristics of the wire prevent it from tangling, unlike the monofilament fishing lines and polypropylene ropes identified in the entanglement literatures.

Given the low potential probability of sea turtles and sea turtle entanglement with control wires, the potential for any harm or harassment to these species is extremely low. *Therefore, there will be no significant impact to sea turtles resulting from interactions with torpedo guidance wire during AFAST active sonar activities within territorial waters under the No Action Alternative, Alternative 1, Alternative 2, or Alternative 3*. In addition, there will be no significant harm to sea turtles resulting from interactions with torpedo guidance wire during AFAST active sonar activities in non-territorial waters under the No Action Alternative, Alternative 1, Alternative 2, or Alternative 3. The torpedo guidance wires associated with AFAST active sonar activities will have no effect on ESA-listed sea turtle species.

4.5.3.2.4 Torpedo Flex Hoses

Improved flex hoses or strong flex hoses will be expended during torpedo exercises. DON (1996) analyzed the potential for the flex hoses to affect sea turtles. This analysis concluded that the potential entanglement effects to marine animals will be insignificant for reasons similar to those stated for the potential entanglement effects of control wires:

- Due to its weight, the flex hoses will rapidly sing to the bottom upon release. With the exception of a chance encounter with the flex hose while it was sinking to the sea floor, a marine animal would be vulnerable to entanglement only if its diving and feeding patterns placed it in contact with the bottom.

- Due to its stiffness, the 76.2-m-long (250-ft-long) flex hose will not form loops that could entangle marine animals.

Therefore, there will be no significant impact to sea turtles resulting from interactions with torpedo flex hoses during AFAST active sonar activities within territorial waters under the No Action Alternative, Alternative 1, Alternative 2, or Alternative 3. In addition, there will be no significant harm to sea turtles resulting from interactions with torpedo flex hoses during AFAST active sonar activities in non-territorial waters under the No Action Alternative, Alternative 1, Alternative 2, or Alternative 3. The torpedo flex hoses associated with AFAST active sonar activities will have no effect on ESA-listed sea turtle species.

4.5.3.2.5 Direct Strikes

The Navy uses the EMATT and the MK-30 acoustic training targets (recovered) during ASW sonar training exercises. The potential for direct physical contact between an EMATT [12 by 91 cm (5 by 36 in) and a sea turtle, or for a direct strike from an MK-30 to a sea turtle, is extremely low given the generally low probability of occurrence of these animals at the immediate location of deployment and the reconnaissance procedures implemented prior to and during exercises. *Therefore, there will be no significant impact to sea turtles resulting from interactions with EMATTs or MK-30s during AFAST active sonar activities within territorial waters under the No Action Alternative, Alternative 1, Alternative 2, or Alternative 3*. In addition, there will be no significant harm to sea turtles resulting from interactions with EMATTs or MK-30s during AFAST active sonar activities in non-territorial waters under the No Action Alternative, Alternative 1, Alternative 2, or Alternative 3. The probability of direct strike of training target associated with AFAST training is negligible and therefore will have no effect on ESA-listed marine mammal species.

4.5.4 Comparison of Potential Sea Turtle Effects by Alternative

There was no appreciable difference between alternatives for exposure to expended materials. Although the amount of materials could be concentrated under Alternatives 1 and 2 as opposed to the No Action Alternative or Alternative 3, all materials are negatively buoyant and are expected to sink. The same reasoning applies to ship strikes; under all four alternatives, the same transit to and from ports is necessary. As such, this section will focus on the results of the acoustical analysis related to the explosive source sonobuoy (AN/SSQ-110A). In comparing the alternatives, Alternatives 1 and 2 were evaluated separately from the No Action Alternative and Alternative 3. The alternatives were grouped in this manner since AFAST active sonar activities under Alternatives 1 and 2 would only occur in specific geographic regions. These restrictions explain the differences in exposure estimates. A summary of acoustic exposure estimates is provided in Table 4-35.

Table 4-35. Summary of Acoustic Exposure Estimates by Alternative

Alternative	Effect		
	Mortality	PTS	TTS
Alternative 1	0	3	12
Alternative 2	0	2	10
Alternative 3	0	2	5
No Action Alternative	0	1	5

As stated in Section 4.5.2, Tables 4-31 through 4-34 reflect rounded exposure numbers. Specifically, exposures numbers were rounded to "1" if the result was equal to or greater than 0.5. Even though an exposure number may have rounded to "0" in an individual analysis area, when summed with all other results for other analysis areas within the AFAST Study Area, an exposure of "1" is possible. The exposure estimates presented in Table 3-34 reflect the rounded exposure numbers.

In general, the exposure estimates for Alternatives 1 and 2 are greater than those for Alternative 3 and the No Action Alternative. The majority of exposures for Alternative 1 (77 percent) and Alternative 2 (67 percent) are associated with the JAX/CHASN OPAREA. Since the activities involving explosive source sonobuoys are confined to a discrete geographical area, the exposure estimates were expected to be slightly higher than those under the No Action Alternative or Alternative 3. This is especially true since sea turtles are likely to be concentrating close to, or over the continental shelf.

4.6 ESSENTIAL FISH HABITAT

The Magnuson-Stevens Act requires federal agencies to consult with the Secretary of Commerce (delegated to the National Marine Fisheries Service) on any action that may adversely affect essential fish habitat (EFH) (16 U.S.C. Section 1855(b)(2)). Pursuant to 50 CFR 600.910(a), an "adverse effect" on EFH is defined as any direct or indirect impact that reduces the quality and/or quantity of EFH. OPNAVINST 5090.1C, incorporating guidance from EFH Final Rule (67 *Federal Register* 2354) and 50 CFR 600.815(a)(2)(ii), further clarifies the definition to state that temporary or minimal impacts are not considered to "adversely affect" EFH. "Temporary impacts" are those that are limited in duration and that allow a particular environment to recover without measurable impact. "Minimal impacts" are those that may result in relatively small changes in the affected environment and insignificant changes in ecological functions. Therefore, an adverse effect on EFH is considered any reduction in quality and/or quantity of EFH that is not minimal or temporary.

4.6.1 Potential Effects to EFH

Adverse effects to EFH could potentially result from detonation of explosive source sonobuoys (AN/SSQ-110A), material introduced into the water column and sediments, and from acoustic effects. Potential water and sediment contaminants could be introduced from unrecovered sonobuoys, torpedo components, ADCs, and EMATTS. Potential effects to each EFH category (as described in Section 3.8) are discussed below.

4.6.1.1 Benthic Habitat and Sediment Interface

Due to the similar nature of benthic and sediment habitats, as well as the common potential effectors resulting from AFAST active sonar activities, these two EFH components are considered together. Sonar operation will have no direct physical effect on benthic habitats or sediments. Activities that could potentially affect these EFH categories include detonation of explosive source sonobuoys (AN/SSQ-110A), scuttling of sonobuoys, and the use of torpedoes, ADCs, and EMATTs.

4.6.1.1.1 Detonation of Explosive Source Sonobuoys (AN/SSQ-110A)

Detonation of explosive source sonobuoys (AN/SSQ-110A) will result in explosive impulses. Such explosive forces could potentially affect EFH by disturbing the sea bottom (benthic and sediment habitats). However, all detonations will occur in the water column at a sufficient distance from the seafloor to avoid disturbance of bottom habitats.

4.6.1.1.2 Scuttled Sonobuoys

Benthic and sediment habitats could also be affected by unrecovered sonobuoys (as well as torpedo components, ADCs, and EMATTs) through either physical disruption or chemical contamination. Potential effects are similar to those discussed in Section 4.3, Marine Habitat, as effects to the seafloor could affect its function as EFH. Expended materials associated with sonobuoys include the parachute assembly, batteries, plastic casings, metal clips, nylon straps, and electrical wiring. The sonobuoys, parachutes (which are weighted) and other components will sink to the ocean floor where they will be buried in the sediment. Over time, these materials will accumulate on the ocean floor. However, the activities using sonobuoys will not likely occur in the exact same location each time. Additionally, the materials will not likely settle in the same vicinity due to ocean currents.

Residual metals derived from scuttled sonobuoy batteries on the ocean floor represent a potential source of sediment contamination. Sediments act as a reservoir for metals that are attracted to particulate organic carbon, and these metals may stress benthic communities. Typical batteries employed include seawater, lithium, and thermal types. Soluble battery constituents of potential concern that may be released into the water column or sediments include lead, silver, and copper. Several other constituents such as chloride, bromide, and lithium may be released as well. Several investigations into the potential effects of battery constituents on seawater and sediment conditions found acceptable levels of such substances (ESG, 2005; Kszos et al., 2003; EPA, 2001; Borener and Maughan, 1998; U.S. Coast Guard, 1994; NAVFAC, 1993). Study results indicate that little accumulation occurred in marine sediments.

4.6.1.1.3 Torpedoes

Expendable materials associated with torpedo use include (depending upon the type of torpedo) guidance wires, flex hoses, protective nose covers, suspension bands, air stabilizers, release wires, propeller baffles, steel-jacketed lead ballast weights, and Otto Fuel II. The relatively small amount of solid material will be spread over a large area. This expended material will settle to the ocean bottom and will be covered by sediments. Over time, materials will accumulate on the ocean floor. However, the TORPEX activities will not likely occur in the exact same location each time. Additionally, the materials will not likely settle in the same vicinity due to ocean currents.

Otto Fuel II is used to propel torpedoes. The combustion byproducts of this fuel include carbon dioxide, carbon monoxide, water, hydrogen gas, nitrogen gas, ammonia, hydrogen cyanide (HCN), and nitrogen oxides. These substances are exhausted into the torpedo wake, which is extremely turbulent and causes rapid mixing and diffusion. This action, combined with rapid dilution in the seawater, makes accumulation of these substances in the sediment unlikely. Such a conclusion is substantiated by the results of the CFMETR EA, which determined that Otto fuel would not cause a measurable effect on sediment quality (ESG, 2005).

Lead ballast weights will be deposited on the seafloor during TORPEX activities. However, the lead is unlikely to mobilize into marine sediments as lead ions for three reasons. First, the lead is jacketed with steel, which means that the surface of the lead would not be exposed directly to the actions of seawater. Second, even if the lead were exposed, the general bottom conditions of slightly basic and low oxygen content (i.e., a reducing environment) would prohibit the lead from ionizing. In addition, only a small percentage of lead is soluble in seawater. Finally, in soft-bottom areas, the lead weights would be buried due to the velocity of their impact with the bottom. Sediments are generally anoxic and thus no lead would be ionized (DON, 1996a). Studies at other ranges have shown the effect of lead ballasts to be minimal, as they are buried deep in sediments where they are not biologically available (Environmental Sciences Group, 2005).

4.6.1.1.4 Acoustic Device Countermeasures

Expendable materials associated with ADCs include batteries, metal casings, and wires. Once expended, these items will sink to the ocean floor and will be covered with sediments over time. The relatively small amount of expended material will be spread over a large area. Over time, these materials will accumulate on the ocean floor. However, the activities will not likely occur in the exact same location each time. Additionally, the materials will not likely settle in the same vicinity due to ocean currents. ADCs are powered by lithium sulfur dioxide batteries. The final battery byproducts include lithium ions, hydroxide (which combines with hydronium to form water), and sulfate. All of these substances are considered benign in the marine environment. In addition, the chemical reactions of the batteries will be highly localized and short-lived, and ocean currents will diffuse concentrations of the chemicals leached by the batteries. Due to the rapid dilution of chemical releases, accumulation of chemicals in sediment and benthic habitats is not likely. This conclusion is substantiated by the results of the CFMETR EA, which determined that lithium in batteries would not cause a measurable effect on sediment quality (ESG, 2005).

4.6.1.1.5 Expendable Mobile Acoustic Training Targets

Expendable materials associated with EMATTs include the parachute assembly, metal casings and clips, nylon straps, electrical wiring, and batteries. EMATTs and their components will scuttle and sink to the ocean floor and will be covered by sediments. The relatively small amount of expended material will be spread over a large area. Over time, these materials will accumulate on the ocean floor. However, the activities will not likely occur in the exact same location each time. Additionally, the materials will not likely settle in the same vicinity due to ocean currents. Like ADCs, EMATTS are powered by lithium sulfur dioxide batteries. The byproducts and potential effects are the same as those discussed for ADCs. Accumulation of chemicals in the sediment and benthic habitats is not likely.

Although expendable materials would likely accumulate on benthic habitats and in the sediment, the effects would not result in significant changes to the ecological functions of these habitats. The effects therefore meet the definition of a minimal impact. In summary, the effects of AFAST active sonar activities to benthic habitats and the sediment interface will be minimal and/or temporary. As such, AFAST active sonar activities will not adversely affect benthic habitats or the sediment interface.

4.6.1.2 Structured Habitats

Activities that could potentially affect human-made and biogenic structured habitats include detonation of explosive source sonobuoys (AN/SSQ-110A), scuttling of sonobuoys, and the use of torpedoes, ADCs, and EMATTs. Explosive forces associated with sonobuoy detonation could affect structured EFH by physical alteration. There is potential for a sonobuoy to be detonated over, an unknown/unmapped bottom structure. The fact that detonations occur at water depths sufficient to prevent disturbance of bottom sediment decreases the likelihood of impulsive effects to structures on the bottom, particularly when the vertical relief is not great.

Scuttled sonobuoys, ADCs, EMATTs, and their associated expendables could be moved by water currents to areas of structured habitat even though the activities were not originally located near such known habitat. Expendable components could then settle onto structures such as artificial reefs, live/hard bottom, or coral reefs. This would more likely occur with objects that sink relatively slowly due to greater water resistance, such as parachutes. Expendables that come to rest on a submerged structure could cause stress or mortality to sedentary benthic organisms by shading (and therefore inhibiting photosynthesis), interfering with passive food collection, or by physical abrasion. The likelihood of such a scenario is unknown and would depend on a number of factors such as location of the activity, direction of water currents at various depths, and physical water parameters. However, the affected area on a given structure would likely be small relative to the overall surface area. For example, the largest parachutes are 18 inches in diameter and guidance wires, while much greater in length, are of small diameter. Heavier objects such as scuttled sonobuoys, ADCs and EMATTs (including batteries), and lead ballast weights would not likely travel great distances, but would settle in the vicinity of the activity. Known structures would not likely be affected because of purposeful avoidance of these habitats; however, expended items could settle onto unknown structures. In addition to shading, interference with food collection, and physical abrasion, metals and battery chemicals could also cause stress or mortality to sedentary benthic organisms or to the structure itself. However, any effects would likely be confined to a small area relative to the total surface area. In addition, encrusting organisms would colonize the expended items over time, slowing the leach rate of any harmful substances.

Although expendable materials could be deposited on known or unknown structures (human-made or biogenic), and sonobuoy detonations could occur over unknown structures, the probability of such events occurring is unknown. Given the total area of such habitats available throughout the AFAST Study Area, the Navy considers that effects would not likely result in significant changes to the ecological functions of these habitats in the aggregate. The effects therefore meet the definition of a minimal impact. In summary, the effects of AFAST active sonar activities to structured habitats will be minimal and/or temporary. As such, AFAST active sonar activities will not adversely affect structured habitats.

4.6.1.3 Pelagic Sargassum

Pelagic *Sargassum* can occur throughout the AFAST Study Area at least seasonally, and the exact location of this habitat at any given time is impossible to predict. Since pelagic *Sargassum* is found floating at the sea surface, often at the convergence of surface currents, and is not associated with the benthic environment, no effect to pelagic *Sargassum* EFH is anticipated from underwater activities. Neither dipping sonar nor sonobuoys would likely be deployed within a *Sargassum* mat, which minimizes the probability of effects due to physical strikes or, in the case of explosive sonobuoys, detonation pressure waves. Therefore, physical disturbance to *Sargassum* would be restricted to the movement of surface vessels. Such disturbance would be temporary and would not differ significantly from other routine maritime traffic. The effects of AFAST active sonar activities to pelagic *Sargassum* habitats will be minimal and temporary. As such, AFAST active sonar activities will not adversely affect pelagic *Sargassum* habitats.

4.6.1.4 Gulf Stream Current

Although surface currents and other circulation features occur at varying spatial and temporal scales throughout the AFAST Study Area, the most dominant oceanographic feature that is designated as EFH is the Gulf Stream Current. The Gulf Stream is a dynamic feature that undergoes constant fluctuations in its physical properties, including its spatial dimensions. Neither surface vessel movement nor underwater activities (submarine movements, target placement, and sonobuoy, ACD, and EMATT activities) will affect EFH associated with the Gulf Stream since the scale the proposed activities is not sufficient to significantly impede or disturb the Gulf Stream Current or to reduce its suitability as EFH. AFAST active sonar activities will not adversely affect Gulf Stream Current EFH.

4.6.1.5 Marine Water Column

Sonar use during AFAST active sonar activities only has the potential to affect living organisms; therefore, sonar operation will have no direct physical effect on the marine water column. Activities that could potentially affect the marine water column include sonobuoys, torpedoes, ADCs, and EMATTs. As discussed in Section 4.3.3 (Water Quality), potential effects to the marine water column from these AFAST activity components result from sonobuoy, ADC, and EMATT batteries, explosive source sonobuoys (AN/SSQ-110A), and Otto Fuel II combustion byproducts and other substances associated with torpedoes.

Activated seawater batteries are of primary concern regarding water quality. Sonobuoy seawater battery electrodes are typically lead chloride, cuprous thiocyanide, or silver chloride. As such, they can release lead, silver, and copper ions that are dissolved in the water column. Lithium batteries are used to power subsurface units. Other constituents, including nickel-plated steel housing, lead solder, copper wire, and lead ballast weights, are considered to pose a smaller risk to the aquatic environment relative to the batteries

The amount of lead leached from lead chloride batteries was found to be below acute and chronic water quality levels established by the EPA (NAVFAC, 1993). Lead chloride is more soluble than the other metals used in seawater batteries. Therefore, potential effects from batteries employing cuprous thiocyanide or silver chloride are substantially lower than those using lead chloride. While the cuprous thiocyanate battery has the potential to release cyanide, thiocyanate is tightly bound and can form a salt or bind to bottom sediments. Therefore, the risk associated with thiocyanate is low. Lithium batteries are used in DICASS sonobuoys. Based on a study conducted by Kszos et al. (2003), as well as on the small amount of lithium expected to leach from batteries, lithium levels in the water column are considered to be non-toxic. Lithium sulfur dioxide batteries are used in ADCs and EMATTs. The ultimate byproducts of these batteries are water and sulfate, which are naturally present in large quantities in seawater. Lithium iron disulfide thermal batteries used in some sonobuoys do not release hazardous chemicals to the water column.

As discussed in Section 4.3.3.3, various byproducts are released into the water column during explosive sonobuoy detonation. The product class with greatest toxicity potential is hydrogen fluoride compounds. No acceptance criteria have been established for hydrogen fluorides in the U.S. However, only a small fraction of these products is expected to become solubilized prior to reaching the surface and solubilized compounds would be dilution with ambient seawater. As such, it is unlikely that the explosive reactions associated with sonobuoys will contribute contaminant risks to the aquatic community.

During TORPEX activities, Otto Fuel II combustion byproducts would be released into the water column. These byproducts include carbon dioxide, carbon monoxide, water, hydrogen gas, nitrogen gas, ammonia, hydrogen cyanide, and nitrogen oxides. The byproducts are released into the torpedoes' wake, which is extremely turbulent and causes rapid mixing and diffusion. The concentration of all byproducts, with the exception of hydrogen cyanide, is below EPA water quality criteria. The concentration of hydrogen cyanide exceeds the 1-hour recommended value; however, hydrogen cyanide is highly soluble in seawater and dilutes below the EPA criterion within 6.3 m (20.7 ft) of the torpedo. The head section of the MK-46 and MK-54 torpedo contains an estimated 109 g (3.7 oz) of sodium fluorescein dye. At the end of the TORPEX, the dye discharges into the seawater to enhance the visibility and facilitate the recovery of the torpedo. This dye is commonly used to trace the flow of water and poses no harm to water quality or aquatic life at the concentrations that will occur during TORPEX operations. MK-46, MK-54, and MK-48 torpedoes contain other potentially hazardous or harmful non-propulsion-related components and materials. However, only very small quantities of these materials are contained in each torpedo. During normal exercise operations, the torpedo is sealed and is recovered at the end of a run; therefore, none of the potentially hazardous or harmful materials would be released to the marine environment. These materials could be released on impact with a target or the sea floor. However, since the guidance system of the torpedo is programmed for target and bottom avoidance, the probability of an accidental release is low. Further, since the amounts of potentially hazardous and harmful materials contained in each torpedo are very small, upon accidental release the materials would rapidly diffuse in the water column.

In summary, the effects of AFAST active sonar activities to the marine water column will be minimal and/or temporary. As such, AFAST active sonar activities will not adversely affect the marine water column.

4.6.1.6 Estuarine and Intertidal Habitats

The only activities that would occur in estuarine and intertidal habitats are active sonar maintenance and object detection/navigational training during transit in and out of port. Maintenance procedures would occur primarily at pier side and would not represent habitat effects beyond those associated with activities currently conducted on a routine basis. During object detection and navigational training, no physical effects will occur to vegetation or any type of soft or hard substrate (intertidal flats, oyster reefs, shell banks, etc.). Potential release of contaminants into the water column by vessels will be within the range of currently ongoing activities. The primary estuarine/intertidal EFH potentially affected by AFAST active sonar activities is submerged aquatic vegetation, which can occur in water depths up to 40 m (130 ft) (Wolfson et. al., 2008). Expended items such as parachutes could be moved by water currents and come to rest on vegetation, resulting in shading (and loss of photosynthetic ability) or physical abrasion. Plastic expendables could ultimately contribute to the overall plastics load and could end up in seagrass beds as well as on intertidal flats and other estuarine habitats. The likelihood of such a scenario is unknown and would depend on a number of factors such as location of the activity, direction of water currents at various depths, and physical water parameters. However, the effected area on a given habitat type would likely be small relative to the overall area available. In summary, the effects of AFAST active sonar activities to estuarine and intertidal habitats will be minimal and/or temporary. As such, AFAST active sonar activities will not adversely affect estuarine and intertidal habitats.

4.6.1.7 Habitat Areas of Particular Concern

HAPCs have generally been addressed in the preceding sections, as they are subsets of EFH. Benthic and sediment habitats would be affected, but the effects would be minimal and temporary. All known areas of live/hard bottom, coral and coral reefs (including the deepwater corals *Oculina* and *Lophelia*), artificial reefs, shipwrecks, and other features that rise above the surrounding seafloor will be avoided. All marine sanctuaries will be avoided as well. Accidental deposition of expended items onto such habitats is possible, but would result in minimal and temporary effects. There would be no effects to pelagic *Sargassum* or to the Gulf Stream Current. No AFAST active sonar activities will occur in estuarine areas. The accidental deposition of such items would result in temporary and localized effects. In summary, there will be no adverse effects to HAPCs as a result of AFAST active sonar activities.

4.6.1.8 Acoustic and Impulsive Effects to Federally Managed Species

Effects to federally managed species and their prey would be similar to effects on other marine fish species (see Section 4.7).

4.7 MARINE FISH

4.7.1 Mid-Frequency and High-Frequency Active Sonar

Effects to marine fish species include acoustic and impulsive effects resulting from the use of sonar and explosive source sonobuoys (AN/SSQ-110A). Fish detect sound in the aquatic environment by two sensory systems: the inner ear and the lateral line system (Ladich and Popper, 2004). In general, the inner ear is used to detect higher frequency sounds while the lateral line detects water motion at low frequencies (below a few hundred Hz) (Hastings and Popper, 2005). A sound source produces both a pressure wave and motion of the medium particles (water molecules in this case), both of which are important to fish. Fish detect particle motion with the inner ear. Pressure signals are initially detected by the gas-filled swim bladder or other air pockets in the body, which then re-radiate the signal to the inner ear (Popper, 2008). Because particle motion attenuates relatively quickly, the pressure component of sound usually dominates as distance from the source increases. The result is that fish without swim bladders are generally sensitive to sound only when they are near the source, whereas fish with swim bladders are sensitive to sound at greater distances.

Hearing in fish has been studied for relatively few species. Results of existing studies indicate that, with a few exceptions, fish cannot hear sounds above 4 kHz and that the majority of species can only detect sounds of about 1 kHz or less (Popper, 2008). Fish can be generally categorized as either hearing specialists or hearing generalists. Hearing specialists can detect a broader frequency range and generally have a lower auditory threshold due to the connection between an air filled cavity (such as a swim bladder) and the inner ear. Specialists detect both the particle motion and pressure components of sound and can generally hear at levels above 1.5 kHz. Hearing generalists are probably limited to detection of the particle motion component of low frequency sounds at relatively high sound intensities (Amoser and Ladich, 2005). Studies indicate that hearing specializations in marine species are rare and that most marine fish are considered hearing generalists (Popper, 2003; Amoser and Ladich, 2005). Moreover, it is thought that the best hearing sensitivity in the majority of marine fish is at or below 0.3 kHz (Popper, 2003). However, it has been demonstrated that marine hearing specialists, such as some of the clupeids (e.g., herrings, shads, menhadens, sardines, anchovies), can detect sounds above 100 kHz. Experiments on marine fish have obtained responses from several clupeids to frequencies up to the range of ultrasound (between 40 and 180 kHz) (University of South Florida, 2007); however, not all clupeid species tested have responded to ultrasound. Alewife (*Alosa pseudoharengus*), blueback herring (*A. aestivalis*), Gulf menhaden (*Brevoortia patronus*), and American shad (A. sapidissima) have shown avoidance to sound at frequencies over 100 kHz (Dunning et al., 1992; Ross et al., 1996; Nestler et al., 2002; Mann et al., 2001; Popper and Carlson, 1998). The *Alosa* species also have relatively low hearing thresholds. Juvenile herring appear to have swim bladder resonance frequencies in the range of 1.0 to 2.0 kHz, and to respond to sounds in this frequency band. In contrast to the clupeids, many other managed fish species are hearing generalists with greatest sensitivity in lower frequencies (below the frequency of most sonars analyzed in this EIS/OEIS).

4.7.1 Acoustic Impacts to Marine Fish

Potential acoustic effects to fishes may be considered in four categories: masking, stress, behavior, and hearing. Masking refers to interference with the ability to hear biologically important sounds. Fish use sounds to detect predators and prey, and for schooling, mating, and navigating, among other uses. Masking of these sounds could have substantial consequences. Navigation by larval fish may be particularly vulnerable to masking. Although some species may be able to produce sound at higher frequencies (greater than 1 kHz), vocal marine fish largely communicate below the range of mid-frequency levels used by most sonars. Further, most marine fish species are not expected to be able to detect sounds in the mid-frequency range of the operational sonars. The few fish species that are known to detect mid-frequencies (including some clupeids) do not have their best sensitivities in the range of the operational sonars. Thus, these fish can only hear mid-frequency sounds when sonars are operating at high energy levels and/or the fish are in close proximity to the sonars. Considering the low frequency detection of most marine species and the limited time of exposure due to the moving sound sources, most sonar used in Study Area would not have the potential to substantially mask key environmental sounds.

Stress refers to biochemical and physiological responses to increases in background sound. The initial response is rapid release of stress hormones into the circulatory system, which causes other responses such as elevated heart rate and blood chemistry changes. Only a limited number of studies have measured biochemical responses by fish to acoustic stress, and the results have varied. Since stress affects human health, it seems reasonable that stress from loud sound may impact fish health, but available information is too limited to adequately address the issue. However, due to the temporary and infrequent nature of sonar use in the Study Area, the resulting stress on fish is not likely to jeopardize the health of resident populations.

Behavioral effects to fish include disruption or alteration of natural activities such as swimming, schooling, feeding, breeding, and migrating. Sudden changes in sound level can cause fish to dive, rise, or change swimming direction. Studies of caged fish have identified three basic behavioral reactions to sound: startle, alarm, and avoidance (Pearson et al., 1992; McCauley et al., 2000; SIO, 2005). Changes in sound intensity may be more important to a fish's behavior than the maximum sound level. Sounds that reach their peak intensity rapidly tend to elicit stronger responses from fish than sounds with longer rise times, but equal peak intensities (Schwarz, 1985). Popper (2008) summarizes the results of experiments showing little to no behavioral response in fish exposed to SURTASS LFA sonar. Although some fish in the vicinity of training exercises may react negatively to sonar, the sounds are relatively temporary and infrequent in nature. Behavioral changes are not expected to have lasting effects on the survival, growth, or reproduction of fish populations. As activities commence, the natural reaction of fish in the vicinity would be to leave the area. When activities are completed, the fish would be expected to repopulate the area.

Studies of hearing effects on fish due to exposure to anthropogenic sounds have generally been of two types (Popper, 2008). The first is exposure of fish to long-term increases in background noise in order to investigate changes in hearing, growth, or survival. The second is exposure to short-duration but high-intensity sounds such as might be produced by sonar or underwater detonations. The results of long-duration studies suggest little to no effect to hearing generalists but potential hearing loss or threshold shifts to hearing specialists. Few robust studies exist on the effects of high intensity sounds on fish. Results of a study involving exposure of three fish species to seismic airguns (average mean peak SPL 207 dB re 1 μPa RL; mean RMS sound level 197 dB re 1 μPa RL; mean SEL 177 dB re 1 $\mu Pa^2 s$) showed temporary hearing loss for a hearing specialist and one hearing generalist, but no hearing loss to a second hearing generalist. Hearing was fully recovered within 18 hours. In another study, rainbow trout and catfish were exposed to SURTASS LFA sonar (maximum RL of 193 dB re 1 μPa at 196 Hz) for approximately 5 to 10 minutes. All catfish and some trout evidenced some temporary hearing loss, while some trout showed no hearing loss. Hearing was fully recovered within 24 hours (catfish) to at least 48 hours (trout). Popper (2008) also provides the results of recent unpublished reports on the effects of mid-frequency sonar (1.5 to 6.5 kHz, received levels of 150 to 189 dB) on larval and juvenile fish. Other than startle movement by herring, there were no behavioral effects detected during or after exposure. In addition, there was no damage to internal organs. The exception was the result of two groups of herring (*Clupea harengus*) exposed to sound pressure levels of 189 dB, where post-exposure mortality was 20 to 30 percent.

In the aggregate, these results suggest that fish hearing could be adversely affected by sonars; temporary threshold shifts would be more likely than permanent hearing loss. However, the magnitude of effects would be affected by several factors. The sounds produced by sonar are relatively temporary and infrequent in nature, and could likely affect the hearing of only a small percentage of overall fish populations. Most marine fish are not expected to be able to detect sounds in the mid-frequency range of operational sonars. The few fish species that have been shown to be able to detect mid-frequencies do not have their best sensitivities in the range of operational sonars. Also, the most commonly used signals will be FM which, in contrast to CW signals, do not produce swim bladder resonance. In addition, the physiological effect of sonars on adult fish is expected to be less than that of juvenile fish because adult fish are in a more robust stage of development, swim bladder frequencies are outside the range of mid-frequency active sonar, and adult fish have more ability to move from an unpleasant stimulus (Kvadsheim and Sevaldsen, 2005). Lasting impact on the survival, growth, or reproduction of fish populations would not be expected.

The discussion above may also be considered in the context of effects to prey species, as many marine fish species are prey items of larger fishes. Clupeids are notable in that many are important prey items, some populations of which have experienced severe decline. For example, the North Carolina Marine Fisheries Commission enacted a harvest moratorium on river herring (blueback herring and alewife) in December 2006 because stocks of these migratory species are considered to be near collapse. Possible causes include loss of habitat due to construction of dams and other impediments, habitat degradation, fishing, and increased predation. Species such as these could therefore be more sensitive to additional effects.

In summary, sonar use could affect marine fish species and their prey by masking ecologically important sounds, inducing stress, altering behaviors, and/or changing hearing thresholds. This could be particularly relevant to the Clupeidae family (herrings), as some species can detect ultrasonic sounds in the range of mid- and high-frequency sonars. However, any such effects would be temporary and infrequent as a vessel operating mid-frequency sonar transits an area. Kvadsheim et al. (2007) reported no behavioral reaction of herrings to low- and mid-frequency sonar. There is no information available to suggest that exposure to non-impulsive acoustic sources results in significant fish mortality on a population level. The only experiments showing mortality in fish due to continuous sound have been investigations on juvenile herring exposed to intense mid-frequency active sonar; however, the level of mortality was considered insignificant in the context of natural daily mortality rates. As such, sonar use will not adversely affect managed species or their prey.

Based on the evaluation presented herein, the likelihood of significant effects to individual fish from active sonar is low. *Therefore, there will be no significant impact to fish populations as a result of active sonar activities in territorial waters under the No Action Alternative, Alternative*

1, Alternative 2, or Alternative 3. In addition, there will be no significant harm to fish populations from active sonar activities in non-territorial waters under the No Action Alternative, Alternative 1, Alternative 2, or Alternative 3.

4.7.2 Impulsive Impacts to Marine Fish

In addition to sounds resulting from sonar activities, marine fish species and their prey could be affected by detonation of explosive sonobuoys. Fish that are located in proximity to a detonation could be killed, injured, or disturbed by the impulsive sound. There currently is no generally accepted threshold for determining effects to fish from explosives other than mortality models. In general, underwater explosions are lethal to most fish species near the detonation regardless of size, shape, or internal anatomy. At farther distances, species with gas-filled swim bladders are more susceptible than those without swim bladders. Larger fishes are generally less susceptible to death or injury than small fish. Species with elongated body forms that are round in cross section may be less susceptible to injury than deep-bodied forms, and orientation of fish relative to the shock wave may affect the extent of injury. Open water pelagic fish (e.g., mackerel) seem to be less affected than reef fishes. Variations in the fish population, including numbers, species, sizes, orientation, and range from the detonation point, make it very difficult to accurately predict mortalities at any specific site of detonation. Most fish species experience large numbers of natural mortalities, especially during early life-stages, and therefore any small level of mortality caused by AFAST active sonar activities involving the explosive source sonobuoy will most likely be negligible to the population as a whole.

Behavioral changes and masking could occur due to sonobuoy detonation. Although some fish in the vicinity of the training exercises may react negatively to the sound of underwater detonations, the sounds are relatively short-term and localized. Behavioral changes are not expected to have lasting effects on the survival, growth, or reproduction of fish populations. As exercises commence, the natural reaction of fish in the vicinity would be to leave the area. When exercises are completed, the fish would be expected to repopulate the area. Given that the energy distribution of an explosion covers a broad frequency spectrum, sound from underwater explosions might overlap with some environmental cues significant to marine fishes. However, the time scale of individual explosions is very limited, and training exercises involving explosions are dispersed in space and time. Thus, the likelihood of underwater detonations resulting in substantial masking is low.

Similar to the effects of sonar, prey items (including invertebrates and prey fish species) could also be affected by underwater detonations. Detonations near prey species would likely result in mortality. Invertebrates do not have the capacity to detect changes in pressure that accompany sound waves (URI, 2007). However, invertebrates are sensitive to particle displacement (Popper et al., 2001). Experiments have shown that some marine invertebrates respond to sound (Popper, 2008), suggesting that detonations could cause prey species to leave an area for some time. However, the limited extent and duration of acoustic influences from detonations in the large AFAST Study Area should not pose a significant threat to prey availability.

In summary, explosive sonobuoy detonations could result in mortality to marine fish species and their prey items located near the detonation point. Fish and prey species located beyond the range of mortality could show a behavioral response. However, due to the wide spacing in the deployment pattern of explosive sonobuoys and the differences in the timing of the detonation, it is unlikely that such results would have lasting effects to populations of fish species. As such, explosive sonobuoy detonations will not adversely affect marine fish species or their prey.

There will be no significant impact to fish from the explosive source sonobuoy (AN/SSQ-110A) in territorial waters under the No Action Alternative, Alternative 1, Alternative 2, or Alternative 3. In addition, there will be no significant harm to fish from the explosive source sonobuoy (AN/SSQ-110A) in non-territorial waters under the No Action Alternative, Alternative 1, Alternative 2, or Alternative 3.

4.7.3 ESA-Listed Fish Species

The shortnose sturgeon, subadult and adult Gulf sturgeon, smalltooth sawfish, and Atlantic salmon are listed as endangered species. In addition, a critical habitat has been designated for the Gulf sturgeon and has been proposed for the Gulf of Maine distinct population segment of Atlantic salmon. The shortnose sturgeon is a coastal/estuarine inhabitant and is not expected to be present within the Study Area. The Gulf sturgeon is not expected to be present in the Study Area since it is a coastal inhabitant and the AFAST Study Area is located outside the Gulf sturgeon's critical habitat. *In accordance with NEPA, there will be no significant impact to the endangered shortnose sturgeon, or subadult and adult Gulf sturgeon from AFAST active sonar activities in territorial waters under the No Action Alternative, Alternative 1, Alternative 2, or Alternative 3.*

In accordance with the ESA, the Navy finds the AFAST active sonar activities will have no effect on the endangered shortnose sturgeon, or subadult and adult Gulf sturgeon. Gulf sturgeon critical habitat is largely restricted to estuarine and inshore areas (behind the barrier island system). One section of critical habitat, from approximately Pensacola to Cape San Blas, Florida, extends seaward of the barrier island system. However, this habitat is defined as only one nautical mile from shore. AFAST active sonar activities will not occur in these areas and are not expected to disturb bottom habitats or the water column. Gulf sturgeon critical habitat will not be destroyed or adversely modified.

The smalltooth sawfish is likely to be present within the Study Area near southwestern peninsular Florida. This portion of the Study Area would include activities involving the explosive source sonobuoy (AN/SSQ-110A). Recent surveys (1990 to 2002) have recorded over 533 sawfish sightings off southwest Florida (Charlotte Harbor to Cape Romano and Ten Thousand Islands), and 1,632 in Florida Bay and the Florida Keys. The Mote Marine Laboratory (MML) has established a Sawfish Encounter Database, which contained 593 verified encounters off Florida and adjacent waters as of April 2005 (Seitz and Poulakis, 2002; Poulakis and Seitz, 2004; Simpfendorfer and Wiley, 2005a). There is a positive correlation between the size, water depth, and distance from shore for this species. Smaller individuals typically utilize habitats close to shore (water less than 1m [3 ft] deep) in areas with inshore bars, mangroves, and seagrass beds possibly to avoid predation by sharks, while larger individuals inhabit deeper waters commonly greater than 70 m (230 ft) but as deep as 122 m (400 ft) (NMFS, 2003b; Poulakis and Seitz, 2004; Simpfendorfer, and Wiley 2005a; 2005b). However, recent tagging studies indicate that adults are only found in deeper waters occasionally and spend more time in shallow water than previously thought (Simpfendorfer and Wiley, 2005a). Therefore, since smaller individuals are found nearshore and larger individuals are only occasionally found in deeper water, it is unlikely that this species would be encountered during explosive source sonobuoy activities. In accordance with EO 12114, there will be no significant harm to smalltooth sawfish from AFAST active sonar activities in non-territorial waters under the No Action Alternative, Alternative 1, Alternative 2, or Alternative 3. In accordance with the ESA, the Navy finds the AFAST active sonar activities will have no effect on the smalltooth sawfish.

The Atlantic salmon Gulf of Maine distinct population segment (DPS) is likely to be present within the northeastern portion of the Study Area. As stated previously, the DPS was defined in 2000 as extending from the lower Kennebec River to (but not including) the mouth of the St. Croix River. In September 2008, NMFS and USFWS expanded the DPS to include all naturally reproducing wild and conservation hatchery populations from the Androscoggin River to the Dennys River. The proposed critical habitat is comprised of 45 areas of river, stream, estuary, and lake habitats within the range of the Gulf of Maine DPS. Currently, the only activities that would occur under the Proposed Action are TORPEXs in the designated boxes in the Boston Complex OPAREA and SCC Ops in the deep waters of the Northeast OPAREAs. It is unlikely, therefore, that this species would be encountered during explosive source sonobuoy activities. In accordance with EO 12114, there will be no significant harm to Atlantic salmon from AFAST active sonar activities in non-territorial waters under the No Action Alternative, Alternative 1, Alternative 2, or Alternative 3. In accordance with the ESA, the Navy finds the AFAST active sonar activities will have no effect on the Atlantic salmon.

4.8 SEA BIRDS

4.8.1 Mid-Frequency and High-Frequency Active Sonar

It is expected the potential effects to seabirds from exposure to mid- and high-frequency active sonar during sonar activities will be the same without regard to the respective OPAREA. Therefore, the sections have been combined and are only differentiated based on whether the animal is listed as a threatened or endangered species.

NMFS issued an Environmental Assessment in 2003 for the purpose of determining whether to issue a scientific research permit for “takes” by “level B harassment” in accordance with the Marine Mammal Protection Act of 1972 (MMPA). The proposed research activity consisted of exposing gray whales to low-powered, high-frequency active sonar while simultaneously recording their reaction to the sound (NMFS, 2003a). The operating frequency of the system proposed was greater than 20 kHz with a maximum source level at or less than 220 dB re 1 μPa at 1 m in individual pulses less than one second for a duty cycle (time on over total time) of less than 10 percent (e.g., in an 8-hour day, maximum sonar use would be 48 minutes) (NMFS, 2003a). As part of the environmental documentation, seabirds were analyzed for potential effects associated with exposure to the active sonar. Little is known about the general hearing or underwater hearing capabilities of sea birds, but research suggests an in-air maximum auditory sensitivity between 1 and 5 kHz for most bird species (NMFS, 2003a). Although the potential hearing capability of seabirds was outside the proposed high-frequency of 20 kHz, it was concluded effects were unlikely even if some diving birds were able to hear the signal for the following reasons:

- There is no evidence seabirds use underwater sound.
- Seabirds spend a small fraction of time submerged.
- Seabirds could rapidly fly away from the area and disperse to other areas if disturbed.

Based on these conclusions, it is reasonable to extend these reasons to mid-frequency active sonar. While it is possible that seabirds are likely to hear some mid-frequency sounds in-air, there is no scientific evidence to suggest birds can hear these sounds underwater. In addition, little published literature exists on the effects of underwater sound to diving birds. A review of available articles indicates that research has been conducted on seismic surveys. During a 3-year study in the Hudson Strait, chemical explosives were used with charge sizes up to 125 kg (276 lbs) during the entire study, while airguns, with an estimated source level of 235 dB re 1 μPa-m, were used the third year only (Turnpenny and Nedwell, 1994). During this study, , airguns did not cause any harm to the seabirds being studied; however, a few deaths did results near the detonation site (Turnpenny and Nedwell, 1994). In another study conducted in the Beaufort Sea, seismic surveys were found to have no effect on the movements or diving behavior of long-tailed ducks (Lacroix et al., 2003).

In general, seabirds spend a short period of time underwater, and as stated in Section 3.10, seabirds rarely fully submerge themselves while feeding. If they do submerge themselves, they typically perform such activities for a short period of time. For example, the Northern gannet has the longest recorded dive depth and dive time of 15 m (49 ft) in 30 seconds (Mowbray, 2002). It is highly unlikely that a seabird would be exposed to active sonar while foraging due to the very short dive time.

Therefore, there will be no significant impact to seabirds from active sonar activities in territorial waters under the No Action Alternative, Alternative 1, Alternative 2, or Alternative 3. In addition, there will be no significant harm to seabirds from active sonar activities in non-territorial waters under the No Action Alternative, Alternative 1, Alternative 2, or Alternative 3.

4.8.2 Explosive Source Sonobuoy (AN/SSQ-110A)

As stated previously, seabirds spend a short period of time underwater and it is extremely unlikely that the detonation of the explosive source sonobuoy (AN/SSQ-110A) will coincide with the dive of a seabird. In addition, very little published literature exists on the effects of underwater detonations to diving birds. During studies conducted on seismic surveys, airguns were not found to have caused any harm to the seabirds being studied (Turnpenny and Nedwell, 1994; Lacroix et al., 2003). However, explosives have resulted in injury, but only when the seabirds occurred near the detonation (Turnpenny and Nedwell, 1994). *Therefore, there will be no significant impact to seabirds from the explosive source sonobuoy (AN/SSQ-110A) in territorial waters under the No Action Alternative, Alternative 1, Alternative 2, or Alternative 3.* In addition, there will be no significant harm to seabirds from the explosive source sonobuoy (AN/SSQ-110A) in non-territorial waters under the No Action Alternative, Alternative 1, Alternative 2, or Alternative 3.

4.8.3 Threatened and Endangered Seabirds

As stated in Section 3.10.4, there are five threatened or endangered birds that may occur within the AFAST Study Area, which include the following:

- Bermuda petrel
- Brown pelican
- Least tern
- Roseate tern
- Piping plover

However, the Bermuda petrel will rarely occur along the East Coast, preferring to nest on islets off Bermuda. Moreover, the two terns and plover prefer beaches and sandbars, while the brown pelican prefers relatively undisturbed coastal islands. As such, AFAST active sonar activities will not disturb any of these ESA-listed seabirds nesting locations. These species may forage coincident with AFAST active sonar activities. However, as stated previously, there is no evidence that seabirds use underwater sound and would only spend a small fraction of time submerged during foraging activities. Furthermore, airguns have not been found to cause any harm to seabirds. Therefore, there will be no effect on threatened or endangered seabirds from active sonar under the No Action Alternative, Alternative 1, Alternative 2, or Alternative 3.

4.8.4 Entanglement

Similar to sea turtles, the potential exists for seabirds to become entangled in expended materials, particularly anything incorporating loops or rings, hooks and lines, or sharp objects. Possible expended materials from AFAST and RDT&E activities are nylon parachutes of varying sizes. At water impact, the parachute assembly is expended and it sinks away from the exercise weapon or target. The parachute assembly will potentially be at the surface for a short time before sinking to the sea floor. Entanglement and the actual drowning of a seabird in a parachute assembly is unlikely, since the parachute would have to land directly on the animal, or a diving seabird would have to be diving exactly underneath the location of the sinking parachute. The potential for a seabird to encounter an expended parachute is extremely low, given the generally low probability of a seabird being in the immediate location of deployment. *Therefore, there will be no significant impact to seabirds from entanglement in territorial waters under the No Action Alternative, Alternative 1, Alternative 2, or Alternative 3.* In addition, there will be no significant harm to seabirds from entanglement in non-territorial waters under the No Action Alternative, Alternative 1, Alternative 2, or Alternative 3.

4.9 MARINE INVERTEBRATES

This section discusses the potential effects of active sonar and the explosive source sonobuoy (AN/SSQ-110A) to marine invertebrates, including shell fish and corals.

4.9.1 Mid-Frequency and High-Frequency Active Sonar

According to the National Research Council of the National Academies (NRC, 2003), there is very little information available regarding the hearing capability of marine invertebrates. A study by Wilson et al. (2007) revealed that squid did not respond or change behavior when exposed to toothed whale echolocation clicks with sound pressure levels ranging from 199 to 226 dB re 1 μPa. In addition, McCauley et al. (2000) noted that one species of squid exhibited behavioral reactions to sounds from seismic airguns at received levels exceeding 156 to 161 dB re 1 μPa mean square pressure (rms). It is important to note that airguns emit a high intensity, low-frequency impulsive sound at relatively short (i.e., 6 to 20 sec [Simmonds, 2004]) intervals for long periods of time; active sonar is not operated in this manner. Since little information is available on marine invertebrates and their hearing, the results of Wilson et al., (2007) are assumed to be indicative of various marine invertebrates to non-impulsive sounds. Based on this limited study, marine invertebrates may not react to mid- and high-frequency sonar. If they do react, the reaction would most likely be a brief since sonar is a transitory and intermittent sound. *Therefore, there will be no significant impact to marine invertebrates as a result of active sonar activities in territorial waters under the No Action Alternative, Alternative 1, Alternative 2, or Alternative 3.* In addition, there will be no significant harm to marine invertebrates from active sonar activities in non-territorial waters under the No Action Alternative, Alternative 1, Alternative 2, or Alternative 3.

4.9.2 Explosive Source Sonobuoy (AN/SSQ-110A)

As stated in the previous section, there is very little information available regarding the hearing capability of marine invertebrates. McCauley et al. (2000) noted that one species of squid exhibited behavioral reactions to sounds from seismic airguns at received levels exceeding 156 to 161 dB re 1 μPa rms. Although these sounds are considered impulsive, these sounds would operate at short intervals for long periods of time. The explosive source sonobuoy (AN/SSQ-110A) would be a single detonation. Further, there is a huge variation in marine invertebrates, including numbers, species, sizes, and orientation and range from the detonation point, which makes it very difficult to accurately predict effects at any specific site of detonation.

Most invertebrates experience large number of natural mortalities especially since they are important foods for fish, reptiles, birds, and mammals. Any small level of mortality caused by the AFAST active sonar activities involving the explosive source sonobuoy (AN/SSQ-110A) will most likely not be significant to the population as a whole. In addition, the explosions associated with the explosive source sonobuoy (AN/SSQ-110A) will be occurring within the water column. Based on the small net explosive weight (NEW) of the explosive, it is not likely that the pressure wave associated with the detonation will reach the bottom, where the majority of invertebrates live. *Therefore, there will be no significant impact to marine invertebrates from the explosive source sonobuoy (AN/SSQ-110A) in territorial waters under the No Action Alternative, Alternative 1, Alternative 2, or Alternative 3.* In addition, there will be no significant harm to marine invertebrates from the explosive source sonobuoy (AN/SSQ-110A) in non-territorial waters under the No Action Alternative, Alternative 1, Alternative 2, or Alternative 3.

4.10 MARINE PLANTS AND ALGAE

This section discusses the potential effects of active sonar and the explosive source sonobuoy (AN/SSQ-110A) to marine plants (seagrasses) and algae (*Sargassum*).

4.10.1 Mid-Frequency and High-Frequency Active Sonar

No effects to marine plants and algae are anticipated from active sonar because plants and algae are acoustically transparent (no ability to be affected by sound). Moreover, ships and submarines will not be operating in the shallow waters where seagrass are present. In addition, *Sargassum* mats are easily identified and will be avoided wherever possible. *Therefore, there will be no significant impact to marine plants and algae as a result of active sonar activities in territorial waters under the No Action Alternative, Alternative 1, Alternative 2, or Alternative 3.* In addition, there will be no significant harm to marine plants and algae from active sonar activities in non-territorial waters under the No Action Alternative, Alternative 1, Alternative 2, or Alternative 3.

4.10.2 Explosive Source Sonobuoy (AN/SSQ-110A)

Explosive source sonobuoy (AN/SSQ-110A) detonations will occur within the water column. Moreover, *Sargassum* mats are easily identified and will be avoided wherever possible. *Therefore, there will be no significant impact to marine plants and algae as a result of explosive source sonobuoy (AN/SSQ-110A)activities in territorial waters under the No Action Alternative, Alternative 1, Alternative 2, or Alternative 3.* In addition, there will be no significant harm to marine plants and algae from explosive source sonobuoy (AN/SSQ-110A) activities in non-territorial waters under the No Action Alternative, Alternative 1, Alternative 2, or Alternative 3.

4.11 NATIONAL MARINE SANCTUARIES

Under the No Action Alternative, Alternative 1, Alternative 2, and Alternative 3, the Navy will not conduct active sonar activities within the Stellwagen Bank, Monitor, Gray's Reef, Flower Garden Banks, and Florida Keys National Marine Sanctuaries and will avoid these sanctuaries by observing a 5 km (2.7 NM) buffer. As discussed in Section 3.13, sanctuary specific prohibitions relative to military operations include:

- Stellwagen Bank: Regulations prohibit operating a vessel (i.e., water craft of any description capable of being used as a means of transportation), or any activity that would threaten or actually destroy, cause the loss of, or injury to a sanctuary resource (e.g., marine mammal, marine reptile, seabird, historical resource).
- Monitor: Regulations prohibit anchoring in any manner, stopping, remaining, or drifting without power; or the detonating of any explosive or explosive mechanism below the surface of the water.

- Gray's Reef: Regulations prohibit the use of underwater explosives or devices that would threaten, destroy, cause injury, or loss of any marine organism.
- Flower Garden Banks: Regulations prohibit activities that would threaten or actually destroy, cause the loss of, or injury to any coral or other bottom formation, coralline algae or other plant, marine invertebrate, brine-seep biota, or carbonate rock within the sanctuary.
- Florida Keys: Regulations prohibit activities that would threaten or actually destroy, cause the loss of, or injury to a sanctuary resource (e.g., marine mammal, marine reptile, seabird, historical resource).

At all times, the Navy will conduct AFAST active sonar activities in a manner that avoids to the maximum extent practicable any adverse impacts on sanctuary resources. In the event the Navy determines AFAST active sonar activities, due to operational requirements, are likely to destroy, cause the loss of, or injure any sanctuary resource (for Stellwagen Bank National Marine Sanctuary, the threshold is "may" destroy, cause the loss of, or injure), the Navy would first consult with the Director, Office of National Marine Sanctuaries in accordance with 16 U.S.C. 1434(d).

Therefore, there would be no significant impact and no significant harm to the Stellwagen Bank, Monitor, Gray's Reef, Flower Garden Banks, and Florida Keys National Marine Sanctuaries under the No Action Alternative, Alternative 1, Alternative 2, or Alternative 3.

4.12 AIRSPACE MANAGEMENT

Changes to airspace can include the introduction of new or modification of existing activities occurring within an airspace area, change in aircraft density, or change in aircraft movements within an airspace area.

There will be no change to existing airspace configuration and scheduling of airspace and Notices to Airmen (NOTAMs) will be completed prior to the activity to ensure aircraft and pilot safety. *Thus, the Navy has determined there will be no effect to airspace management within the territorial portion of the AFAST Study Area from implementing the No Action Alternative, Alternative 1, Alternative 2, or Alternative 3.* Moreover, there will be no effect to airspace management within the non-territorial portion of the AFAST Study Area from implementing the No Action Alternative, Alternative 1, Alternative 2, or Alternative 3.

4.13 ENERGY (WATER, WIND, OIL, AND GAS)

This section provides analysis for the potential of AFAST active sonar activities to affect water energy development, wind farms, as well as oil and gas exploration.

4.13.1 Atlantic Ocean, Offshore of the Southeastern United States

Currently, there is a development and improvement project for the infrastructure located offshore of Dania Beach, Florida, near Fort Lauderdale by Ocean Renewable Power Company (ORPC). Additional sites have been identified in Miami, Florida and West Palm Beach, Florida.

There are currently no wind farms located along the southeast coast of the United States, nor are any proposed for future development. Moreover, no active gas or oil exploration leases exist in the Atlantic. Therefore, there will be no effect to water energy development, wind farms, or gas and oil exploration from AFAST active sonar activities off the southeastern United States under the No Action Alternative, Alternative 1, Alternative 2, or Alternative 3.

4.13.2 Atlantic Ocean, Offshore of the Northeastern United States

Currently, Verdant Power operates the Roosevelt Island Tidal Energy Project in the East River near New York City. In addition, there is a proposed project off the coast of Eastport, Maine, as well as sites proposed for Piscataqua River (between Maine and New Hampshire); Merrimack River, Massachusetts; Amesbury, Massachusetts; and Indian River Inlet, Delaware. However, all of these locations are located outside the AFAST Study Area.

There are no existing wind farms, or gas or oil leases along the northeast coast of the United States. Therefore, there will be no effect to water energy development, wind farms, or gas and oil exploration from AFAST and RDT&E activities off the northeastern United States under the No Action Alternative, Alternative 1, Alternative 2, or Alternative 3.

4.13.3 Eastern Gulf of Mexico

Currently, there are no existing or proposed water energy developments or wind farms in the eastern Gulf of Mexico. However, oil and gas drilling is occurring in non-territorial portions of the eastern Gulf of Mexico. The proposed AFAST active sonar activities do not include any increases in tempo over past activities or any changes in locations. The U.S. Navy has held exercises in the Gulf of Mexico previously and no effects to oil and gas drilling platforms have been documented. Therefore, there will be no effect to water energy development or wind farms from AFAST and RDT&E activities in the eastern Gulf of Mexico under the No Action Alternative, Alternative 1, Alternative 2, or Alternative 3. Moreover, there will be no significant harm to oil and gas drilling from AFAST and RDT&E activities in non-territorial waters under the No Action Alternative, Alternative 1, Alternative 2, or Alternative 3.

4.13.4 Western Gulf of Mexico

Currently, there are no existing water energy developments or wind farms in the western Gulf of Mexico. However, oil drilling is occurring in territorial and non-territorial portions of the western Gulf of Mexico. The proposed AFAST active sonar activities do not include any increases in tempo over past activities or any changes in locations. The U.S. Navy has held exercises in the Gulf of Mexico previously and no effects to oil and gas drilling platforms have been documented. Therefore, there will be no effect to water energy developments wind farms from AFAST and RDT&E activities in the western Gulf of Mexico under the No Action

Alternative, Alternative 1, Alternative 2, or Alternative 3. *There will be no significant impact to oil and gas drilling from AFAST and RDT&E activities in territorial waters off the eastern coast of Texas under the No Action Alternative, Alternative 1, Alternative 2, or Alternative 3.* In addition, there will be no significant harm to oil and gas drilling from AFAST and RDT&E activities in non-territorial waters off the eastern coast of Texas under the No Action Alternative, Alternative 1, Alternative 2, or Alternative 3.

4.14 RECREATIONAL BOATING

This analysis examines the potential effect active sonar activities may have to recreational boating. Specifically, a significant effect would occur if boaters were unable to take part in recreational activities due to public closures.

Under all alternatives, the majority of active sonar activities will occur within, adjacent, or seaward of existing OPAREAs in non-territorial (greater than 12.2 km [12 NM]) waters. (The majority of recreational boating activities occur in territorial waters.) Since it is expected that potential conflicts with recreational boaters could occur under all alternatives, the analysis was performed without regard to specific OPAREAs. The Navy does not close off ocean areas for active sonar activities; as such, no restrictions to recreational boaters are imposed and no conflicts to fishing activities would occur. A Notice to Mariners (NOTAMs) or other public notice would be given at least 72 hours in advance of a torpedo launching event.

Therefore, there will be no significant impacts to recreational boating from active sonar activities conducted in territorial waters under the No Action Alternative, Alternative 1, Alternative 2, or Alternative 3. In addition, there will be no significant harm to recreational boating from active sonar activities conducted in non-territorial waters under the No Action Alternative, Alternative 1, Alternative 2, or Alternative 3.

4.15 COMMERCIAL AND RECREATIONAL FISHING

This analysis examines the potential effect that active sonar activities may have to commercial and recreational fishing. Specifically, a significant effect would occur if boaters were unable to take part in recreational activities due to public closures.

Under all alternatives, various active sonar activities will occur within, adjacent, or seaward of existing OPAREAs. Since commercial and recreational fishing provide a large economic output for certain states, including Florida, Texas, and North Carolina, the analysis was performed with regard to specific OPAREAs.

4.15.1 Atlantic Ocean, Offshore of the Southeastern United States

Recreational fishing primarily occurs along the coasts of the southern states ranging from Florida to Virginia. Catches and participation are generally increasing or stable in these regions for coastal and territorial waters while the quantity of fish caught, the amount of trips taken, and the number of anglers participating are decreasing for federal waters.

Various organizations host recreational fishing tournaments during the year along the southeastern Atlantic coast from central Florida to Maryland. The majority of tournaments take place during the weekends followed by activities extending from the middle of the week to weekends and from Friday through Sunday. The majority of fishing takes place in areas near canyons and humps, including such places as Edisto Banks (Georgia to North Carolina), Washington Canyon (Virginia and Maryland), Poorman's Canyon (Virginia and Maryland), and Norfolk Canyon (Virginia). No effects to or changes to fishing tournaments have been documented for previous naval exercises; therefore, no conflicts would be anticipated under any of the alternatives.

The majority of commercial fish landings by weight and by value in the southeastern Atlantic coast, like recreational fishing activities there, occur in state waters. The only exception is for the value of fisheries in the Virginia area where 61 percent of the finances of commercial fishing come from federal waters. Otherwise, as much as 92 percent of the weight and 63 percent of the value of commercial fisheries arise from state waters in Virginia and North Carolina, respectively. In Florida, the percentage is 55 percent by weight and 60 percent by value. Thus, commercial fishing is more heavily tied to coastal areas where the Navy conducts limited sonar activities (maintenance, navigational use, and some helicopter dipping sonar use). Furthermore, there are no significant effects to fish from the associated analysis presented in Section 4.7, Marine Fish.

Since there are no increases in tempo or intensity over past exercises and the majority of commercial and recreational fishing is connected with coastal areas, there will be no significant effect on this resource. Further, since the Navy does not close off ocean areas for active sonar activities no restrictions or conflicts with commercial or recreational fishermen are likely to occur. Navy active sonar activities in state waters include sonar maintenance, navigational use, and other routine activities that the Navy will carry out going into and out of port or at the pier. *Therefore, there will be no significant impact to recreational or commercial fishing from active sonar activities conducted in territorial waters in the western Atlantic Ocean offshore of the southeastern United States under the No Action Alternative, Alternative 1, Alternative 2, or Alternative 3.* Moreover, there will be no significant harm to recreational and commercial fishing from active sonar activities conducted in non-territorial waters in the western Atlantic Ocean offshore of the southeastern United States under the No Action Alternative, Alternative 1, Alternative 2, or Alternative 3.

4.15.2 Atlantic Ocean, Offshore of the Northeastern United States

Commercial and recreational fishing occur within the various OPAREAs of the northeastern Atlantic coast. The potential exists for temporary disruptions to occur to recreational and commercial fishing within waters of the northeastern Atlantic coast. The majority of recreational fishing off of the northeastern Atlantic coast, including Maine, Massachusetts, and Rhode Island, takes place in state and territorial waters, where catch numbers and participation has increased. Activities have generally decreased in federal waters. For example, in Maine and in the Atlantic City OPAREA, catch has gone down in federal waters by 83 percent and 44 percent, respectively.

Sportfishing tournaments occur throughout the year from New Jersey to Maine. A large proportion of the activities take place during the weekend beginning on Friday and ending Saturday or Sunday; however, longer tournaments, which make up the majority of the activities along the northeastern Atlantic coast, begin either Wednesday or Thursday and/or extend through the following Monday or Tuesday. The majority of fishing takes place at hotspots like canyons and humps. No effects to or changes to fishing tournaments have been documented for previous naval exercises; therefore, no conflicts would be anticipated under any of the alternatives. The majority of commercial fish landings by value along the northeastern Atlantic coast are nearly equal for federal and state waters at 51 percent and 49 percent, respectively. However, up to 67 percent of the commercial landings by weight are caught in federal waters.

Since there are no increases in tempo or intensity over past exercises and the Navy does not close off ocean areas for active sonar activities, no restrictions or conflicts with commercial or recreational fishermen are likely to occur. Furthermore, there are no significant effects to fish from the associated analysis presented in Section 4.7, Marine Fish. *Therefore, there will be no significant impact to recreational or commercial fishing from active sonar activities conducted in territorial waters in the western Atlantic Ocean offshore of the northeastern United States under the No Action Alternative, Alternative 1, Alternative 2, or Alternative 3.* Moreover, there will be no significant harm to recreational and commercial fishing from active sonar activities conducted in non-territorial waters in the western Atlantic Ocean offshore of the northeastern United States under the No Action Alternative, Alternative 1, Alternative 2, or Alternative 3.

4.15.3 Eastern Gulf of Mexico

In this area of the Gulf of Mexico, the number of participants in recreational fishing is increasing. Although catch is generally increasing throughout the region, the amount of landings is declining along the west coast of Florida. Sport fishermen take in the majority of landings from state waters.

Two large fishing tournaments are held each year in the eastern Gulf of Mexico. The Mobile Big Game Fishing Club Memorial Day Tournament is held in Orange Beach, Alabama, and the Bay Point Billfish Invitational Tournament in Panama City, Florida. These activities occur from Friday to Monday and from Friday to Sunday, respectively. The majority of fishing takes place on artificial reefs and hotspots such as like canyons and humps. No effects to or changes to fishing tournaments have been documented for previous naval exercises; therefore, no conflicts would be anticipated under any of the alternatives.

Unlike the other regions discussed previously, commercial landings occur in offshore, federal waters. The commercial fishing industry lands nearly 59 percent and 70 percent of landings by weight and by value, respectively, in these waters.

Since there are no increases in tempo or intensity over past exercises and the Navy does not close off ocean areas for active sonar activities, no restrictions or conflicts with commercial or recreational fishermen are likely to occur. Furthermore, there are no significant effects to fish from the associated analysis presented in Section 4.7, Marine Fish. *Therefore, there will be no significant impact to recreational or commercial fishing from active sonar activities conducted in territorial waters in the eastern Gulf of Mexico under the No Action Alternative, Alternative 1*

Alternative 2, or Alternative 3. Moreover, there would be no significant harm to recreational and commercial fishing from active sonar activities conducted in non-territorial waters in the eastern Gulf of Mexico under the No Action Alternative, Alternative 1, Alternative 2, or Alternative 3.

4.15.4 Western Gulf of Mexico

Recreational fishing has decreased in Texas on investigation of the number of anglers participating in the sport. Like most other regions, the majority of recreational fishing takes place only a few miles from the coast.

Major fishing tournaments in the western Gulf of Mexico occur from Venice, Louisiana, to South Padre Island, Texas. The majority of the activities in the region generally run from the middle of the week through the weekend and the largest prizes encompass various billfishes. The majority of fishing takes place on artificial reefs and at hotspots like canyons and humps. No effects to or changes to fishing tournaments have been documented for previous naval exercises; therefore, no conflicts would be anticipated under any of the alternatives.

The majority of commercial fishing activities in the western Gulf of Mexico encompass nearshore trawling for shrimp. Additional significant fishery operations target finfish and shellfish. Of the four largest ports in Texas, two are situated in east Texas, one is located in central Texas, and one exists in west Texas. The major fishery, shrimping, occurs in coastal, nearshore waters. Commercial landings occur in offshore, federal waters. Specifically, the commercial fishing industry lands nearly 59 percent and 70 percent of landings by weight and by value, respectively, in these waters.

Since there are no increases in tempo or intensity over past exercises and the Navy does not close off ocean areas for active sonar activities, no restrictions or conflicts with commercial or recreational fishermen are likely to occur. Furthermore, there are no significant effects to fish from the associated analysis presented in Section 4.7, Marine Fish. *Therefore, there will be no significant impact to recreational or commercial fishing from active sonar activities conducted in territorial waters in the western Gulf of Mexico under the No Action Alternative, Alternative 1, Alternative 2, or Alternative 3.* Moreover, there will be no significant harm to recreational and commercial fishing from active sonar activities conducted in non-territorial waters in the western Gulf of Mexico under the No Action Alternative, Alternative 1, Alternative 2, or Alternative 3.

4.16 COMMERCIAL SHIPPING

This section addresses potential effects to commercial shipping associated with the proposed active sonar training along the east coast and in the Gulf of Mexico. Typical considerations include location of shipping lanes in relation to Navy training, the amount of shipping activities, and the potential for disruption to the industry. Since commercial shipping is such an important industry, the analysis was performed with regard to specific OPAREAs.

4.16.1 Atlantic Ocean, Offshore of the Southeastern United States

Shipping routes exist throughout the nearshore and offshore waters of the southeastern United States The Virginia Capes (VACAPES) OPAREA encompasses seven major shipping lanes while only three lanes occur within the CHPT OPAREA. The Jacksonville/Charleston (JAX/CHASN) complex contains the highest amount of shipping channels with over 20 present there. Representative routes include the Atlantic-Puerto Rico Access and the Atlantic-Panama Access. The total area of shipping lanes within the southeastern United States is small compared with the amount of water available for training in this portion of Atlantic Ocean.

Past records of U.S. Navy training indicate no significant effects to commercial shipping have occurred. No significant effects to commercial shipping have been documented from previous Navy exercises, and the Proposed Action represents no increase in activity or change in location from where sonar activities have been conducted. *Therefore, there will be no significant impact to commercial shipping from active sonar activities conducted in territorial waters in the western north Atlantic offshore of the southeastern United States under the No Action Alternative, Alternative 1, Alternative 2, or Alternative 3.* Moreover, there will be no significant harm to commercial shipping from active sonar activities conducted in non-territorial waters in the western north Atlantic offshore of the southeastern United States with the No Action Alternative, Alternative 1, Alternative 2, or Alternative 3.

4.16.2 Atlantic Ocean, Offshore of the Northeastern United States

Shipping lanes exist throughout the nearshore and offshore waters of the northeastern United States, although less concentrated as compared with the southeastern United States. About 15 shipping lanes exist in this region with the same representative routes as the northeastern United States, including the Atlantic-Puerto Rico Access and the Atlantic-Panama Access.

The ocean area for training by the U.S. Navy will be significantly more than the area encompassed by shipping routes. Additionally, no significant effects to commercial shipping have been documented from previous active sonar training. No significant effects to commercial shipping have been documented from previous Navy exercises, and the Proposed Action represents no increase in activity or change in location from where sonar activities have been conducted. *Therefore, there will be no significant impact to commercial shipping from active sonar activities conducted in territorial waters in the western north Atlantic offshore of the northeastern United States under the No Action Alternative, Alternative 1, Alternative 2, or Alternative 3.* Moreover, there will be no significant harm to commercial shipping from active sonar activities conducted in non-territorial waters in the western north Atlantic offshore of the northeastern United States under the No Action Alternative, Alternative 1, Alternative 2, or Alternative 3.

4.16.3 Eastern Gulf of Mexico

Shipping lanes overlap with some portions of the active sonar areas in the eastern Gulf of Mexico. At least 20 major channels exist in this region. Representative shipping routes include the Gulf Deepwater Spine. The area of water available for active sonar training will encompass significantly more area than that of the shipping lanes in the eastern Gulf of Mexico. No significant effects have been documented on commercial shipping by the Navy exercises.

No significant effects to commercial shipping have been documented from previous Navy exercises, and the Proposed Action represents no increase in activity or change in location from where sonar activities have been conducted. *Therefore, there will be no significant impact to commercial shipping from active sonar activities conducted in territorial waters in the eastern Gulf of Mexico under the No Action Alternative, Alternative 1, Alternative 2, or Alternative 3.* Moreover, there will be no significant harm to commercial shipping from active sonar activities conducted in non-territorial waters in the eastern Gulf of Mexico under the No Action Alternative, Alternative 1, Alternative 2, or Alternative 3.

4.16.4 Western Gulf of Mexico

MIW training will occur in areas where shipping lanes are present in the western Gulf of Mexico. Fifteen major channels exist off of the state of Texas. These lanes represent the Gulf-Panama Access and the Gulf-Deepwater Access; many of the channels include service routes for the energy exploration and offshore drilling industry. No significant effects to commercial shipping have been documented from previous Navy exercises, and the Proposed Action represents no increase in activity or change in locations.

No significant effects to commercial shipping have been documented from previous Navy exercises, and the Proposed Action represents no increase in activity or change in location from where sonar activities have been conducted. *Therefore, there will be no significant impact to commercial shipping from active sonar activities conducted in territorial waters in the western Gulf of Mexico under the No Action Alternative, Alternative 1, Alternative 2, or Alternative 3.* Moreover, there will be no significant harm to commercial shipping from active sonar activities conducted in non-territorial waters in the western Gulf of Mexico under the No Action Alternative, Alternative 1, Alternative 2, or Alternative 3.

4.17 SCUBA DIVING

This section analyzes the potential effects (either adverse or beneficial) to scuba diving activities. Typical considerations include potential effects related to dive trips and to the safety of recreational divers. Since scuba diving is a popular recreational activity in coastal states, the analysis was performed with regard to specific geographic regions. As stated previously, the PADI suggests that certified openwater divers limit their dives to 18 m (60 ft). More experienced divers are generally limited to 30 m (100 ft); in general, no recreational diver should exceed 40 m (130 ft) (PADI, 2006). However, most sonar use occurs 22.2 km (12 NM) from shore and at depths not suitable for recreational diving.

4.17.1 Atlantic Ocean, Offshore of the Southeastern United States

There are relatively few natural reefs in waters off the eastern United States and none north of Georgia’s east coast, because corals require warm, tropic temperatures to thrive. Most coral reefs occur in shallow nearshore waters where the water remains relatively warm year-round. These reefs are popular destinations for recreational divers. In addition, many popular dive sites are considered cultural resources (historic shipwrecks) will already be included in areas to avoid due to their status as a reef or cultural resource.

Since the locations of the popular diving spots are well documented and dive boats (typically well marked) and diver-down flags will be visible from the ships conducting the routine training, no interactions between recreational divers and Navy operations are likely to occur. In addition, The Naval Sea Systems Command Instruction (NAVSEAINST) 3150.2, “Safe Diving Distances from Transmitting Sonar,” is the Navy’s governing document for human divers in relation to mid-frequency active sonar systems. That instruction provides procedures for calculating safe distances from active sonars. Such procedures are derived from experimental and theoretical research conducted at the Naval Submarine Medical Research Laboratory and the Naval Experimental Diving Unit. Inputs to those procedures include diver dress, type of sonar, and distance from the sonar. The output is represented as a permissible exposure limits (i.e., how long the diver can safely stay at that exposure level). For example, a diver wearing a wetsuit without a hood has a permissible exposure limit of 71 minutes at a distance of 914 m (3,000 ft) from the AN/SQS-53 sonar. That same instruction advises that if the type of sonar is unknown, divers should start 914 m (3,000 ft) from the source and move closer (as needed) to the limits of diver comfort. If an interaction did occur, it is unlikely the active sonar activity would not be conducted close enough to a diver to trigger the permissible exposure limit.

Therefore, there will be no significant impact to scuba diving from active sonar activities conducted in territorial waters in the western north Atlantic offshore of the southeastern United States under the No Action Alternative, Alternative 1, Alternative 2, or Alternative 3. Moreover, there will be no significant harm to scuba diving from active sonar activities conducted in non-territorial waters in the western north Atlantic offshore of the southeastern United States under the No Action Alternative, Alternative 1, Alternative 2, or Alternative 3.

4.17.2 Atlantic Ocean, Offshore of the Northeastern United States

Recreational diving activities within the western north Atlantic take place primarily at known diving sites. Unlike the southeastern United States where coral reefs exist from Georgia southward, the Northeast OPAREAs comprise mainly man-made artificial reefs and shipwrecks. As described in Section 3.19, known diving sites exist throughout each of the OPAREAs.

Possible interactions between U.S. Navy operations within the offshore areas and recreational scuba divers will be minimized because the locations of the popular diving spots are well documented and because dive boats (typically well marked) and diver-down flags will be visible from the ships conducting the routine training. Furthermore, most training activities will take place offshore at depths of 182.9 m (600 ft) or more; thus, it is highly unlikely that any interactions between recreational divers and training exercises will occur given that they will not be in close enough proximity to one another. If an interaction did occur, it is unlikely the active sonar activity would not be conducted close enough to a diver to trigger the permissible exposure limit.

Therefore, there will be no significant impact to scuba diving from active sonar activities conducted in territorial waters in the western north Atlantic offshore of the northeastern United States under the No Action Alternative, Alternative 1, Alternative 2, or Alternative 3. Moreover, there will be no significant harm to scuba diving from active sonar activities conducted in non-territorial waters in the western north Atlantic offshore of the northeastern United States under the No Action Alternative, Alternative 1, Alternative 2, or Alternative 3.

4.17.3 Eastern Gulf of Mexico

Recreational diving is a popular sport in the eastern Gulf of Mexico, where attractions include a number of artificial reefs and shipwrecks. Only small patches of coral exist in the eastern Gulf of Mexico with greater concentrations occurring in such areas as the Flower Garden Banks. Furthermore, the locations of the popular diving spots have been well documented and dive boats (typically well marked) and diver-down flags will be visible from the ships conducting the routine training; thus, no adverse effects are anticipated to recreational divers. If an interaction did occur, it is unlikely the active sonar activity would not be conducted close enough to a diver to trigger the permissible exposure limit. Furthermore, the *Therefore, there will be no significant impact to scuba diving from active sonar activities conducted in territorial waters in the eastern Gulf of Mexico under the No Action Alternative, Alternative 1, Alternative 2, or Alternative 3.* Moreover, there will be no significant harm to scuba diving from active sonar activities conducted in non-territorial waters in the eastern Gulf of Mexico under the No Action Alternative, Alternative 1, Alternative 2, or Alternative 3.

4.17.4 Western Gulf of Mexico

Like the eastern Gulf of Mexico, the western portion also provides opportunities for recreational diving. As with the previous sections, dive boats and diver-down flags will be visible from ships conducting training. If an interaction did occur, it is unlikely the active sonar activity would not be conducted close enough to a diver to trigger the permissible exposure limit.

Therefore, there will be no significant impact to scuba diving from active sonar activities conducted in territorial waters in the western Gulf of Mexico under the No Action Alternative, Alternative 1, Alternative 2, or Alternative 3. Moreover, there will be no significant harm to scuba diving from active sonar activities conducted in non-territorial waters in the western Gulf of Mexico under the No Action Alternative, Alternative 1, Alternative 2, or Alternative 3.

4.18 MARINE MAMMAL WATCHING

Marine mammal watching (whale watching), as defined in Section 3.20, includes the conduct of tours by boat, aircraft, or from land to view cetaceans. Whale watching is also considered a category of marine tourism that can include activities, formal or informal, where people view, swim with, or listen to any cetacean species. The cetacean species targeted during tours includes dolphins, whales, and porpoises. In the northeast, the industry focuses on the various whales summering in waters off of New England and include sightings of harbor porpoises while in the southeast and Gulf of Mexico, operators often target the Atlantic bottlenose dolphin. The following subsections look at whale watching in relation to the respective active sonar areas.

4.18.1 Atlantic Ocean, Offshore of the Southeastern United States

Whale watching in this region occurs within a few miles of shore and rarely in federal waters. Based on the distribution and abundance of the various marine mammal species and the location of these popular ports for whale watching, the most commonly viewed cetaceans in the southeastern Atlantic coast portion of the AFAST Study Area include coastal and nearshore populations of Atlantic bottlenose dolphins and humpback whales (Hoyt, 2001).

Whale watching targets primarily bottlenose dolphins along the southeastern Atlantic coast and generally extends from April through November. Operations occur in areas where concentrations of coastal and nearshore populations of dolphins are abundant. Tours typically last from one to two hours in such hotspots for dolphin watching as the Virginia Beach, Virginia; Nags Head, North Carolina; and Hilton Head Island, South Carolina. Thus, the potential for interactions between the U.S. Navy and dolphin-watch activities to occur will exist primarily during one-half of each year and will take place on a short duration given the time-limited characteristics of typical dolphin cruises. However, the Navy does not close off ocean areas for active sonar activities, and dolphin-watch activities will generally occur in coastal waters, where only a few AFAST active sonar activities will occur.

Due to the fact that most Navy active sonar activities would occur in federal waters and that the Navy does not close off ocean areas for active sonar activities, conflicts between active sonar activities and whale watching in the southeast is unlikely. *Therefore, there will be no significant impact to whale watching from active sonar activities conducted in territorial waters in the western north Atlantic offshore of the southeastern United States under the No Action Alternative, Alternative 1, Alternative 2, or Alternative 3.* Moreover, there will be no significant harm to whale watching from active sonar activities conducted in non-territorial waters in the western north Atlantic offshore of the southeastern United States under the No Action Alternative, Alternative 1, Alternative 2, or Alternative 3.

4.18.2 Atlantic Ocean, Offshore of the Northeastern United States

Whale watching occurs within a few miles of shore and rarely in federal waters. The most commonly viewed cetaceans in the northeastern Atlantic coast include humpback whales, fin whales, right whales, minke whales, sei whales, Atlantic white-sided dolphins, and harbor porpoises (Hoyt, 2007). The height of whale watching in New England generally occurs from April through October. Thus, the potential for effects to the industry will exist primarily during late spring through early fall. Tours range typically from three to six hours in length, with an average duration of three and one-half to four hours (Whale and Dolphin Conservation Society [WDCS], 2007).

Due to the fact that most Navy active sonar activities would occur in federal waters and that the Navy does not close off ocean areas for active sonar activities, conflicts between active sonar activities and whale watching in the northeast is unlikely. *Therefore, there will be no significant impact to whale watching from active sonar activities conducted in territorial waters in the western north Atlantic offshore of the northeastern United States under the No Action Alternative, Alternative 1, Alternative 2, or Alternative 3.* Moreover, there will be no significant harm to whale watching from active sonar activities conducted in non-territorial waters in the western north Atlantic offshore of the northeastern United States under the No Action Alternative, Alternative 1, Alternative 2, or Alternative 3.

4.18.3 Eastern Gulf of Mexico

Whale watching occurs within a few miles of shore and rarely in federal waters. The most commonly viewed cetaceans in this portion of the Gulf of Mexico include Atlantic bottlenose dolphins, Atlantic spotted dolphins, and sperm whales (Hoyt, 2001). Within the eastern Gulf of Mexico, tours generally last from one and a quarter to three and one-half hours, with average trip durations of two hours. Naval activities in the eastern Gulf of Mexico will occur seaward of the shelf break in federal waters.

Due to the fact that most Navy active sonar activities would occur in federal waters and that the Navy does not close off ocean areas for active sonar activities, conflicts between active sonar activities and whale watching in the eastern Gulf of Mexico is unlikely. *Therefore, there will be no significant impact to whale watching from active sonar activities conducted in territorial waters in the eastern Gulf of Mexico under the No Action Alternative, Alternative 1, Alternative 2, or Alternative 3.* Moreover, there will be no significant harm to whale watching from active sonar activities conducted in non-territorial waters in the eastern Gulf of Mexico under the No Action Alternative, Alternative 1, Alternative 2, or Alternative 3.

4.18.4 Western Gulf of Mexico

Similar to whale watching along the southeastern Atlantic coast and in the eastern/central Gulf of Mexico, tours generally target coastal and nearshore populations of dolphins that are within a few miles of shore and rarely in federal waters. These trips generally last between one and two hours. Similar to the eastern/central Gulf of Mexico, the most commonly viewed cetaceans in the western Gulf of Mexico includes Atlantic bottlenose dolphins, Atlantic spotted dolphins, and sperm whales (Hoyt, 2001).

Due to the fact that Navy active sonar activities in the western Gulf of Mexico would occur in waters approximately 13 to 17 km (7 to 9 NM) from shore, and that the areas will not be closed off for active sonar activities, conflicts between active sonar activities and whale watching in the western Gulf of Mexico is unlikely. *Therefore, there will be no significant impact to whale watching from active sonar activities conducted in territorial waters in the western Gulf of Mexico under the No Action Alternative, Alternative 1, Alternative 2, or Alternative 3.* Moreover, there will be no significant harm to whale watching from active sonar activities conducted in non-territorial waters in the western Gulf of Mexico under the No Action Alternative, Alternative 1, Alternative 2, or Alternative 3.

4.19 CULTURAL RESOURCES AT SEA

Potential cultural resources within the AFAST Study Area include prehistoric and historic resources (predominately shipwrecks) as well as man-made obstructions. Prehistoric resources, in depths of less than approximately 100 m (328 ft) may be cultural resources (or archaeological sites) that remain from Pre-Paleo or Paleoindian habitations prior to the last ice age, when sea levels were much lower (Pleistocene Era which occurred prior to 10,000 before present [B.P.]. However, these sites will be buried under deep layers of sediments that have accumulated over the centuries; thus, they will not be affected by AFAST or RDT&E activities.

In addition, sonar is not expected to affect cultural resources, especially since the explosions associated with the explosive source sonobuoy (AN/SSQ-110A) will occur within the water column and will not reach the ocean floor. Therefore, this section will focus on the potential effects that expended materials associated with the sonobuoys and torpedoes will have on cultural resources (shipwrecks). Since cultural resources are unique to specific geographic regions, the analysis was conducted with regard to each OPAREA. Potential effects are expected to be the same under the No Action Alternative, Alternative 1, and Alternative 2; thus, alternatives are combined for discussion purposes.

4.19.1 Atlantic Ocean, Offshore of the Southeastern United States

Known shipwrecks are located within and adjacent to the VACAPES, CHPT, and JAX/CHASN OPAREAs. Many details, including latitudes and longitudes, of submerged wrecks and obstruction in coastal waters of the United States are cataloged in the Automated Wreck and Obstruction Information System (AWOIS). As discussed in Section 4.3, the small size and low density of expended materials will not cause effects to the sediment stability on the ocean bottom. *Therefore, there will be no significant impact to cultural resources from active sonar activities conducted in territorial waters in the western north Atlantic, offshore of the southeastern United States under the No Action Alternative, Alternative 1, Alternative 2, or Alternative 3.* Moreover, there will be no significant harm to cultural resources from active sonar activities conducted in non-territorial waters in the western north Atlantic, offshore of the southeastern United States under the No Action Alternative, Alternative 1, Alternative 2, or Alternative 3.

4.19.2 Atlantic Ocean, Offshore of the Northeastern United States

No known cultural resources lie within the northeastern OPAREAs. *Therefore there will be no impact to cultural resources from active sonar activities conducted in territorial waters in the western north Atlantic, offshore of the northeastern United States under the No Action Alternative, Alternative 1, Alternative 2, or Alternative 3.* Moreover, there will be no significant harm to cultural resources from active sonar activities conducted in non-territorial waters in the western north Atlantic, offshore of the northeastern United States under the No Action Alternative, Alternative 1, Alternative 2, or Alternative 3.

4.19.3 Eastern Gulf of Mexico

Known shipwrecks are located in the eastern Gulf of Mexico. Many details, including latitudes and longitudes, of submerged wrecks and obstruction in coastal waters of the United States are cataloged in the AWOIS. As discussed in Section 4.3, the small size and low density of expended materials will not cause effects to the sediment stability on the ocean bottom. *Therefore, there will be no significant impact to cultural resources from active sonar activities conducted in territorial waters in the eastern Gulf of Mexico under the No Action Alternative, Alternative 1, Alternative 2, or Alternative 3.* Moreover, there will be no significant harm to cultural resources from active sonar activities conducted in non-territorial waters in the eastern Gulf of Mexico under the No Action Alternative, Alternative 1, Alternative 2, or Alternative 3.

4.19.4 Western Gulf of Mexico

Many known shipwrecks lie offshore of the Texas coast, particularly along Padre Island, Matagorda Bay, and Corpus Christi Bay. Many details, including latitudes and longitudes, of submerged wrecks and obstruction in coastal waters of the United States are cataloged in the AWOIS. As discussed in Section 4.3, the small size and low density of expended materials will not cause effects to the sediment stability on the ocean bottom. *Therefore, there will be no significant impact to cultural resources from active sonar activities conducted in territorial waters in the western Gulf of Mexico under the No Action Alternative, Alternative 1, Alternative 2, or Alternative 3.* Moreover, there will be no significant harm to cultural resources from active sonar activities conducted in non-territorial waters in the western Gulf of Mexico under the No Action Alternative, Alternative 1, Alternative 2, or Alternative 3.

4.20 COASTAL ZONE CONSISTENCY DETERMINATION

The Coastal Zone Management Act (CZMA) of 1972 (16 U.S.C. 1451 "*et seq*".) was enacted to protect coastal resources from growing demands associated with commercial, residential, recreational and industrial uses. The CZMA allows coastal states to develop a Coastal Zone Management Plan (CZMP) whereby they designate permissible land and water use within the state's coastal zone. States then have the opportunity to review and comment on federal agency activities that could affect the state's coastal zone or its resources.

Federal agency activities potentially affecting a state's coastal zone must be consistent, to the maximum extent practicable, with the enforceable policies of the state's coastal management program. Enforceable policies of a state's coastal management plan generally consist of existing state statutes and codes that have been combined to comprise the CZMP. Typically, a state's CZMP will focus on the protection of physical, biological, and socioeconomic resources.

Review of federal agency activities is conducted through the submittal of either a Consistency Determination or a Negative Determination. A federal agency shall submit a Consistency Determination when it determines that its activity may have either a direct or an indirect effect on a state's coastal zone or resources. In accordance with 15 CFR 930.39, the consistency determination shall include a brief statement indicating whether the proposed activity will be undertaken in a manner consistent to the maximum extent practicable with the enforceable policies of the management program and should be based upon an evaluation of the relevant enforceable policies of the management program.

Pursuant to 15 CFR 930.41, the state has 60 days from the receipt of the Consistency Determination in which to concur with or object to the Consistency Determination, or to request an extension under 15 CFR 930.41(b). Federal agencies shall approve one request for an extension period of 15 days or less.

A federal agency may submit a Negative Determination to a coastal state when the federal agency has determined that its activities would not have an effect on the state's coastal zone or its resources or when conducting the same or similar activities for which Consistency Determinations have been prepared in the past. Pursuant to 15 CFR 930.35 the state has 60 days to review a federal agency's Negative Determination. States are not required to concur with a Negative Determination, and if the federal agency has not received a response from the state by the 60^{th} day of submittal, it may proceed with its action. However, within the 60-day review period, a state agency may request, and the federal agency shall approve, one request for an extension period of 15 days or less.

In accordance with the CZMA, the U.S. Navy has reviewed the enforceable policies of each state's CZMP located within the Study Area. Based on the limitations discussed in Section 2.4, the enforceable policies of each state's CZMP, and pursuant to 15 CFR 930.39, the U.S. Navy has prepared Consistency Determinations for the states of Connecticut, Florida, Georgia, Texas, and Virginia. Appendix F contains the U.S. Navy's Consistency Determinations associated with the Proposed Action. Additionally, the U.S. Navy will prepare Negative Determinations pursuant to 15 CFR § 930.35 for the states of Alabama, Delaware, Louisiana, Maine, Maryland, Massachusetts, Mississippi, New Hampshire, New Jersey, New York, North Carolina, Pennsylvania, Rhode Island, and South Carolina. Refer to Appendix F for additional information.

4.21 ENVIRONMENTAL JUSTICE AND RISKS TO CHILDREN

The Council on Environmental Quality's (CEQ's) Environmental Justice Guidance under NEPA (1997) identifies factors that are to be considered to the extent practicable when determining whether environmental effects to minority populations and low-income populations are disproportionately high and adverse. These factors include whether there is or will be an effect on the natural or physical environment that significantly (as delineated in NEPA) and adversely affect a minority population, low-income population, or Indian tribe. The "significance" language is specific to NEPA and not part of the Executive orders. Such effects may include ecological, cultural, human health, economic, or social effects when those effects are interrelated to effects to the natural or physical environment. Other factors to be considered if significant and adverse effects are projected include: (1) whether they will appreciably exceed those same effects to the general population or other appropriate comparison group, and (2) whether these populations have been affected by cumulative or multiple exposures from environmental hazards.

The methods to conduct the effects analysis for environmental justice included a review of conclusions for resources discussed in this chapter. If significant effects were identified or if the identified effects considered were disproportionately high and adverse for the purposes of the environmental justice analysis (i.e., effects that exceeded an accepted threshold or standard and will potentially affect the public), an evaluation would have been conducted to determine if further analysis was needed to determine if effects could disproportionately fall on minority populations or low-income populations. This EIS/OEIS has determined that there will be no significant impacts to geology, water quality, marine habitat, airspace management, cultural resources, and socioeconomics within territorial or non-territorial waters under the No Action Alternative, Alternative 1, Alternative 2, or Alternative 3. In addition, the active sonar activities that are described in this EIS/OEIS are not new and do not involve significant changes in systems, tempo, or intensity from past events. *Therefore, implementation of the Proposed Action would not pose disproportionate high or adverse effects to minority or low-income populations, or environmental health and safety risks to children.*

4.22 UNAVOIDABLE ADVERSE IMPACTS

Unavoidable adverse effects could occur during current and emerging active sonar training, maintenance, and RDT&E activities as described in this document. Potential unavoidable adverse effects resulting from implementation of the Proposed Action would be limited to exposure of marine mammals (endangered and threatened, and non-endangered and threatened) to underwater sound associated with mid- and high-frequency active sonar and explosive source sonobuoys (AN/SSQ-110A). In addition, endangered sea turtles may be exposed to underwater sound from explosive source sonobuoys (AN/SSQ-110A). We consider this unavoidable, because marine mammals and turtles are mobile and can enter an area at any time. The adverse effects that could occur resulting from implementation of the Proposed Action cannot be avoided; as previously stated in Section 1.2, Title 10 of the United States Code, Section 5062 requires the Navy to be "organized, trained, and equipped primarily for prompt and sustained combat incident to operations at sea." The current and emerging active sonar training, maintenance, and RDT&E activities addressed in this AFAST Final EIS/OEIS are conducted in fulfillment of this legal requirement. The mitigations presented in Chapter 5 will be implemented to reduce the potential for exposures to these animals to underwater sound. In addition, the Navy is consulting with NMFS in accordance with the MMPA and Section 7 of the ESA.

4.23 RELATIONSHIP BETWEEN SHORT-TERM USES OF THE HUMAN ENVIRONMENT AND THE ENHANCEMENT OF LONG-TERM PRODUCTIVITY

There would be no effects that would adversely affect the long-term productivity of implementing the Proposed Action within the territorial waters. There would be some short-term effects to the environment; however, they would be brief and localized

4.24 IRREVERSIBLE AND IRRETRIEVABLE COMMITMENT OF RESOURCES

Implementation of the Proposed Action would irretrievably commit the use of nonrenewable resources such as fuel, materials, and human labor. Destruction of submerged cultural or historical resources would also be considered an irretrievable commitment because these resources are irreplaceable. However, the Navy avoids these areas, which makes the potential interaction with cultural or historical resources very unlikely.

The Proposed Action would inevitably require the use of some nonrenewable resources. However, the action is not expected to result in the destruction or degradation of environmental resources to the point that their use is appreciably limited presently or in the future. The Navy, through operational constraints and mitigation measures, would minimize the irreversible and irretrievable commitment of resources present within the operating area.

5. MITIGATION MEASURES

Effective training dictates that ship, submarine, and aircraft participants utilize their sensors to their optimum capabilities as required by mission. The Department of the Navy (DON) recognizes that such use has the potential to cause behavioral disruption of some marine mammal species in the vicinity of training, as discussed in Chapter 4. This chapter presents the Navy's mitigation measures that would be implemented as part of the Proposed Action to protect marine mammals and federally listed species. It should be noted that several of these mitigation measures align with mitigation measures for unit-level training that the Navy has had in place since 2004. In addition, the Navy coordinated with the National Marine Fisheries Service (NMFS) to further develop measures for protection of marine mammals during the timeframe necessary to complete this Environmental Impact Statement/Overseas Environmental Impact Statement (EIS/OEIS). Those mitigations for mid-frequency active sonar are detailed below. This chapter also presents a discussion of other measures that have been considered and rejected because they either: (1) are not feasible or reasonable, (2) present a safety concern, (3) provide no known or ambiguous protective benefit; or (4) impact the effectiveness of the required military readiness activity.

The final suite of measures developed in Navy's application for a Marine Mammal Protection Act (MMPA) Letter of Authorization (LOA) are analyzed in this Atlantic Fleet Active Sonar Training (AFAST) Final EIS/OEIS. In addition to the National Environmental Policy Act (NEPA) process, the public had an opportunity to provide input to NMFS through the MMPA process, both during the comment period following NMFS' Notice of Receipt of the application for a MMPA LOA, and during the comment period following NMFS' publication of the proposed rule. In order to make the findings necessary to issue the MMPA authorization, it may be necessary for NMFS to require additional mitigation or monitoring measures beyond those addressed in this AFAST Final EIS/OEIS. If additional mitigation or monitoring measures are required, they will be included in the AFAST Record of Decision.

For the purposes of the Endangered Species Act (ESA) Section 7 consultation, the mitigation measures proposed here may be considered by NMFS as beneficial actions taken by the federal agency or applicant (50 CFR 402.14[g][8]). If required to satisfy requirements of the ESA, NMFS may develop an additional set of measures contained in Reasonable and Prudent Alternatives, Reasonable and Prudent Measures, or Conservation Recommendations in any Biological Opinion issued for this Proposed Action.

5.1 MITIGATION MEASURES RELATED TO ACOUSTIC EFFECTS

The Navy recognizes that the proposed action might cause behavioral disruption of some marine mammal species (as outlined in Chapter 4) in the Study Area and is therefore seeking a Biological Opinion and incidental take statement from NMFS. This chapter describes the Navy's proposed mitigation measures that would be implemented to protect marine mammals during the proposed active sonar activities.

The typical ranges, or distances – from the most powerful and common active sonar sources used in AFAST to received sound energy levels associated with a temporary threshold shift (TTS) and permanent threshold shift (PTS) – are shown in Figure 5-1. In addition, the range to effects for explosive source sonobuoys (AN/SSQ-110A) are shown in Figure 5-2. Due to spreading loss, sound attenuates logarithmically from the source, so the area in which an animal could be exposed to potential injury (PTS) is small. Because the most powerful sources would typically be used in deep water and the range to effect is limited, spherical spreading is assumed for 195 decibels referenced to 1 micro-Pascal squared second (dB re $1\mu Pa^2$-s) and above. Also, due to the limited ranges, interactions with the bottom or surface ducts are rarely an issue.

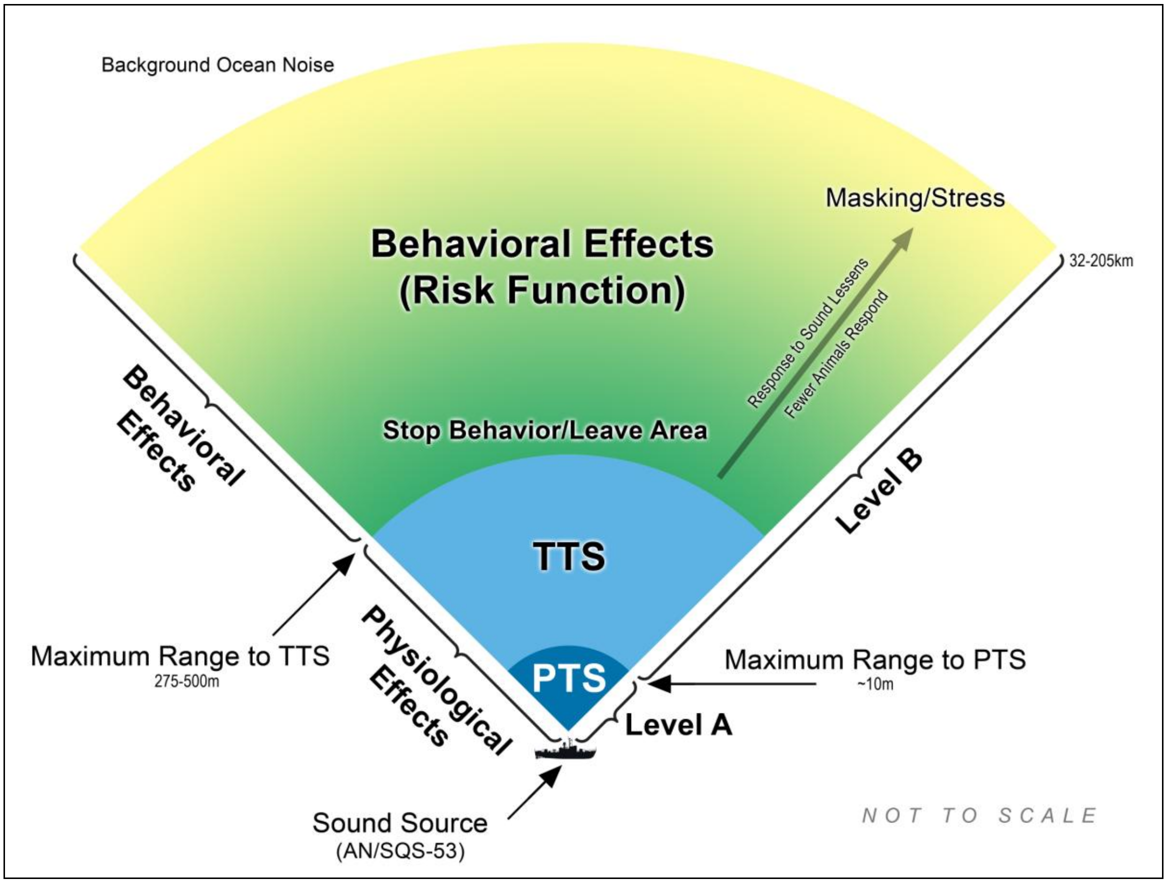


Figure 5-1. Range to Effects for the Most Powerful Active Sonar, AN/SQS-53

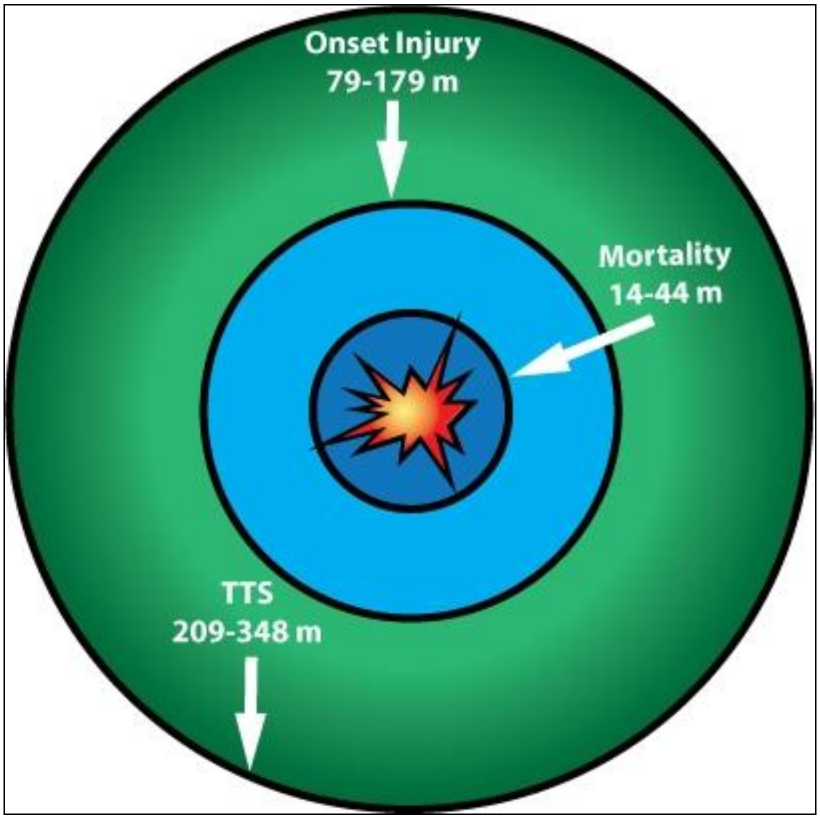


Figure 5-2. Range to Effects for Explosive Source Sonobuoys (AN/SSQ-110A)
Note: Range to mortality conservatively based on dolphin calf criteria

5.1.1 Personnel Training

Navy shipboard lookouts are highly qualified and experienced marine observers. At all times, shipboard lookouts are required to sight and report all objects found in the water to the Officer of the Deck. Objects (e.g., trash, periscope) or disturbances (e.g., surface disturbance, discoloration) in the water may indicate a threat to the vessel and its crew. Navy lookouts undergo extensive training to qualify as a watchstander. This training includes on-the-job instruction under the supervision of an experienced watchstander, followed by completion of the Personal Qualification Standard (PQS) program, certifying that they have demonstrated the necessary skills to detect and report partially submerged objects. In addition to these requirements, many watchstanders periodically undergo a two-day refresher training course.

Marine mammal mitigation training for those who participate in the active sonar activities is a key element of the mitigation measures. The goal of this training is twofold: (1) that active sonar operators understand the details of the mitigation measures and are competent to carry out the mitigation measures, and (2) that key personnel onboard Navy platforms exercising in the various Navy Operating Areas (OPAREAs) understand the mitigation measures and are competent to carry them out.

For the past few years, the Navy has implemented marine mammal spotter training for its bridge lookout personnel on ships and submarines. This training has been revamped and updated as the

Marine Species Awareness Training (MSAT) and is provided to all applicable units. The lookout training program incorporates MSAT, which addresses the lookout's role in environmental protection, laws governing the protection of marine species, Navy stewardship commitments, and general observation information, including more detailed information for spotting marine mammals. MSAT has been reviewed by NMFS and acknowledged as suitable training. MSAT would also be provided to the following personnel:

- **Bridge personnel on ships and submarines** – Personnel would continue to use the current marine mammal spotting training and any updates.
- **Aviation units** – Pilots and air crew personnel whose airborne duties during Anti-Submarine Warfare (ASW) operations include searching for submarine periscopes would be trained in marine mammal spotting. These personnel would also be trained on the details of the mitigation measures specific to both their platform and that of the surface combatants with which they are operating.
- **Sonar personnel on ships, submarines, and ASW aircraft** – Sonar operators aboard ships, submarines, and aircraft who are participating in AFAST exercises would be trained in the details of the mitigation measures relative to their platform. Training would also target the specific actions to be taken if a marine mammal is observed.

5.1.2 Procedures

The following procedures would be implemented to maximize the ability of operators to recognize instances when marine mammals are in the vicinity.

5.1.2.1 General Maritime Mitigation Measures: Personnel Training

- All lookouts aboard platforms involved in ASW training activities will review NMFS-approved MSAT material prior to using mid-frequency active sonar.
- All Commanding Officers, Executive Officers, and officers standing watch on the bridge, maritime patrol aircraft aircrews, and ASW/Mine Warfare (MIW) helicopter crews will complete MSAT prior to a training activity that employs the use of sonar.
- Navy lookouts would undertake extensive training in order to qualify as a watchstander in accordance with the Lookout Training Handbook (Naval Education and Training Command Manual [NAVEDTRA] 12968-D).
- Lookout training would include on-the-job instruction under the supervision of a qualified, experienced watchstander. Following successful completion of this supervised training period, lookouts would complete the PQS program, certifying that they have demonstrated the necessary skills (such as detection and reporting of partially submerged objects). This does not forbid personnel being trained as lookouts from inclusion in previous measures as long as supervisors monitor their progress and performance.
- Lookouts would be trained to quickly and effectively communicate within the command structure in order to facilitate implementation of mitigation measures if marine species are spotted.

5.1.2.2 General Maritime Mitigation measures: Lookout and Watchstander Responsibilities

- On the bridge of surface ships, there would always be at least three personnel on watch whose duties include observing the water surface around the vessel.
- In addition to the three personnel on watch, all surface ships participating in ASW exercises would have at least two additional personnel on watch as lookouts at all times during the exercises.
- Personnel on lookout and officers on watch on the bridge would have at least one set of binoculars available for each person to aid in the detection of marine mammals.
- On surface vessels equipped with mid-frequency active sonar, pedestal-mounted "Big Eye" (20 x 110) binoculars will be present and will be maintained in good working order to assist in the detection of marine mammals near the vessel.
- Personnel on lookout would follow visual search procedures employing a scanning methodology in accordance with the Lookout Training Handbook (NAVEDTRA 12968-D).
- Surface lookouts would scan the water from the ship to the horizon and be responsible for all contacts in their sector. In searching the assigned sector, the lookout would always start at the forward part of the sector and search aft (toward the back). To search and scan, the lookout would hold the binoculars steady so the horizon is in the top third of the field of vision and direct their eyes just below the horizon. The lookout would scan for approximately five seconds in as many small steps as possible across the field seen through the binoculars. They would search the entire sector through the binoculars in approximately five-degree steps, pausing between steps for approximately five seconds to scan the field of view. At the end of the sector search, the glasses would be lowered to allow the eyes to rest for a few seconds, and then the lookout would search back across the sector with the naked eye.
- After sunset and prior to sunrise, lookouts would employ Night Lookout Techniques in accordance with the Lookout Training Handbook.
- At night, lookouts would not sweep the horizon with their eyes, because eyes do not see well when they are moving. Lookouts would scan the horizon in a series of movements that would allow their eyes to come to periodic rests as they scan the sector. When visually searching at night, they would look a little to one side and out of the corners of their eyes, paying attention to the things on the outer edges of their field of vision. Lookouts will also have night vision devices available for use.
- Personnel on lookout would be responsible for informing the Officer of the Deck of all objects or anomalies sighted in the water (regardless of the distance from the vessel), since any object or disturbance (e.g., trash, periscope, surface disturbance, discoloration) in the water may indicate a threat to the vessel and its crew or the presence of a marine species that may need to be avoided, as warranted.

5.1.2.3 Operating Procedures

- Commanding Officers would make use of marine species detection cues and information to limit interaction with marine species to the maximum extent possible, consistent with the safety of the ship.
- All personnel engaged in passive acoustic sonar operation (including aircraft, surface ships, or submarines) would monitor for marine mammal vocalizations and report the detection of any marine mammal to the appropriate watch station for dissemination and appropriate action. The Navy can detect sounds within the human hearing range due to an operator listening to the incoming sounds. Passive acoustic detection systems are used during all ASW activities.
- During operations involving sonar, personnel would use all available sensor and optical systems (such as night vision goggles to aid in the detection of marine mammals).
- Navy aircraft participating in exercises at sea would conduct and maintain, when operationally feasible and safe, surveillance for marine species of concern as long as it does not violate safety constraints or interfere with the accomplishment of primary operational duties.
- Aircraft with deployed sonobuoys would use only the passive capability of sonobuoys when marine mammals are detected within 183 meters (m) (200 yards [yd]) of the sonobuoy.
- Marine mammal detections by aircraft would be immediately reported to the assigned Aircraft Control Unit (if participating) for further dissemination to ships in the vicinity of the marine species. This action would occur when it is reasonable to conclude that the course of the ship will likely close the distance between the ship and the detected marine mammal.
- When marine mammals are detected by any means (aircraft, shipboard lookout, or acoustically) within 914 m (1,000 yd) of the sonar dome (the bow), the ship or submarine would limit active transmission levels to at least 6 decibels (dB) below normal operating levels.
- Ships and submarines would continue to limit maximum transmission levels by this 6 dB factor until the animal has been seen to leave the area, has not been detected for 30 minutes, or the vessel has transited more than 1,829 m (2,000 yd) beyond the location of the last detection.
- Should a marine mammal be detected within 457 m (500 yd) of the sonar dome, active sonar transmissions would be limited to at least 10 dB below the equipment's normal operating level. Ships and submarines would continue to limit maximum ping levels by this 10 dB factor until the animal has been seen to leave the area, has not been detected for 30 minutes, or the vessel has transited more than 1,829 m (2,000 yd) beyond the location of the last detection.
- Should the marine mammal be detected within 183 m (200 yd) of the sonar dome, active sonar transmissions would cease. Sonar would not resume until the animal has been seen to leave the area, has not been detected for 30 minutes, or the vessel has transited more than 1,829 m (2,000 yd) beyond the location of the last detection.

- If the need for power-down should arise, as detailed in "Safety Zones" above, Navy staff would follow the requirements as though they were operating at 235 dB - the normal operating level (i.e., the first power-down would be to 229 dB, regardless of the level above 235 db the sonar was being operated).
- Prior to start up or restart of active sonar, operators would check that the safety zone radius around the sound source is clear of marine mammals.
- Sonar levels (generally) – The Navy would operate sonar at the lowest practicable level, not to exceed 235 dB, except as required to meet tactical training objectives.
- Helicopters would observe/survey the vicinity of an ASW exercise for 10 minutes before the first deployment of active (dipping) sonar in the water.
- Helicopters would not dip their sonar within 183 m (200 yd) of a marine mammal and would cease pinging if a marine mammal closes within 183 m (200 yd) after pinging has begun.
- Submarine sonar operators would review detection indicators of close-aboard marine mammals prior to the commencement of ASW operations involving active mid-frequency sonar.

5.1.2.4 Special Conditions Applicable for Bow-Riding Dolphins

If, after conducting an initial maneuver to avoid close quarters with dolphins, the ship concludes that dolphins are deliberately closing in on the ship to ride the vessel's bow wave, no further mitigation actions would be necessary because dolphins are out of the main transmission axis of the active sonar while in the shallow-wave area of the vessel bow.

5.1.3 Additional Mitigation Measures Developed by NMFS and the Navy

NMFS and Navy worked together to identify additional practicable and effective mitigation measures to address the following three issues of concern: (1) general minimization of marine mammal impacts; (2) minimization of impacts within the southeastern North Atlantic right whales critical habitat; and (3) the potential relationship between the operation of mid- and/or high-frequency active sonar and marine mammal strandings. Any mitigation measure(s) prescribed by NMFS should be able to accomplish, have a reasonable likelihood of accomplishing (based on current science), or contribute to the accomplishment of one or more of the general goals listed below:

- Avoidance or minimization of injury or death of marine mammals wherever possible.
- A reduction in the numbers of marine mammals (total number or number at biologically important time or location) exposed to received levels of mid- or high-frequency active sonar, underwater detonations, or other activities expected to result in the take of marine mammals (this goal may contribute to the goal above, or by reducing harassment takes only).
- A reduction in the number of times (total number or number at biologically important time or location) individuals would be exposed to received levels of mid- or high-frequency active sonar, underwater detonations, or other activities expected to result in

the take of marine mammals (this goal may contribute to the first goal listed above or by reducing harassment takes only).

- A reduction in the intensity of exposures (either total number or number at biologically important time or location) to received levels of mid- or high-frequency active sonar, underwater detonations, or other activities expected to result in the take of marine mammals (this goal may contribute to a, above, or to reducing the severity of harassment takes only).
- A reduction in adverse effects to marine mammal habitat, paying special attention to the food base, activities that block or limit passage to or from biologically important areas, permanent destruction of habitat, or temporary destruction/disturbance of habitat during a biologically important time.
- For monitoring directly related to mitigation – an increase in the probability of detecting marine mammals, thus allowing for more effective implementation of the mitigation (shut-down zone, etc.).

NMFS and the Navy had extensive discussions regarding mitigation, in which we explored several mitigation options and their respective practicability. Ultimately, NMFS and the Navy developed the measures listed below, which we believe support (or contribute) to the goals mentioned above.

- The Navy has designated several Planning Awareness Areas (PAAs) (see Figure 5-3) based on areas of high productivity that have been correlated with high concentrations of marine mammals (such as persistent oceanographic features like upwellings associated with the Gulf Stream front where it is deflected off the east coast near the Outer Banks), and areas of steep bathymetric contours that are frequented by deep diving marine mammals such as beaked whales and sperm whales. In developing the PAAs, U.S. Fleet Forces (USFF) was able to consider these factors because of geographic flexibility in conducting ASW training. USFF is not tied to a specific range support structure for the majority of the training for AFAST. Additionally, the topography and bathymetry along the East Coast and in the Gulf of Mexico is unique in that there is a wide continental shelf leading to the shelf break affording a wider range of training opportunities.
    - The Navy shall avoid planning major exercises in the specified PAAs (Figure 5-3) where feasible. Should national security require the conduct of more than four major exercises (Composite Training Unit Exercise [COMPTUEX], Joint Task Force Exercise [JTFEX], Southeastern ASW Integrated Training Initiative [SEASWITI], or similar scale event) in these areas (meaning all or a portion of the exercise) per year the Navy shall provide NMFS with prior notification and include the information in any associated after-action or monitoring reports.
    - To the extent operationally feasible, the Navy plans to conduct no more than one of the four above-mentioned major exercises (COMPTUEX, JTFEX, SEASWITI, or similar scale event) per year in the Gulf of Mexico. Based on operational requirements, the exercise area for this one exercise may include the De Soto Canyon. If national security needs require more than one major exercise to be conducted in the PAAs, which includes portions of the DeSoto Canyon, the Navy would provide

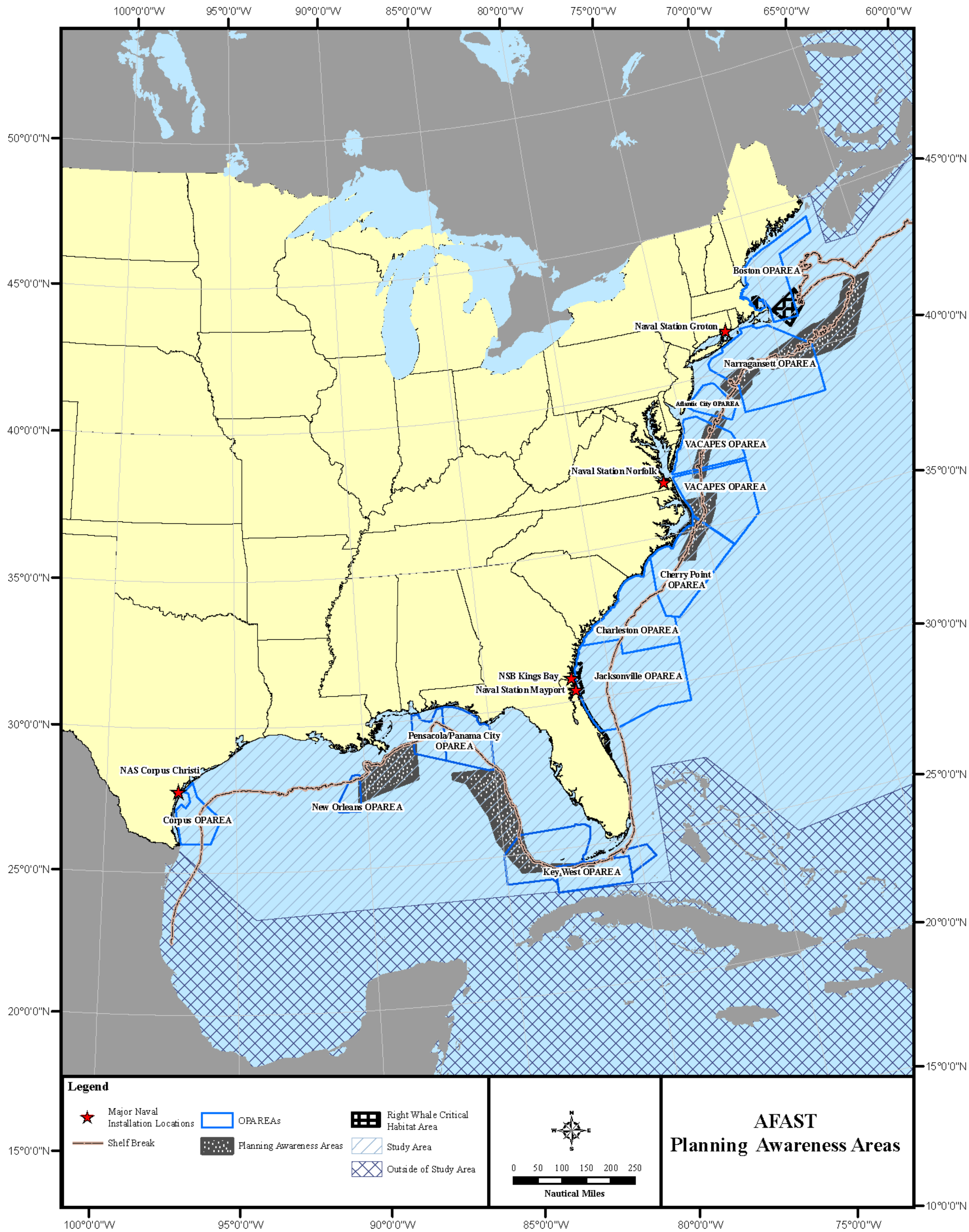


Figure 5-3. AFAST Planning Awareness Areas

NMFS with prior notification and include the information in any associated after-action or monitoring reports.

- ◦ The PAAs will be included in the Navy's Protective Measures Assessment Protocol (PMAP) (implemented by the Navy for use in the protection of the marine environment) for unit level situational awareness (i.e., exercises other than COMPTUEX, JTFEX, or SEASWITI). The goal of PMAP is to raise awareness in the fleet and ensure common sense and informed oversight are injected into planning processes for testing and training evolutions.

- Helicopter Dipping Sonar in North Atlantic right whale Critical Habitat
  - ◦ Helicopter Dipping Sonar is one of the two activity types that has been identified as planned to occur in the southern North Atlantic right whale critical habitat. Historically, only maintenance of helicopter dipping sonars occurs within a portion of the North Atlantic right whale critical habitat. Tactical training with helicopter dipping sonar does not typically occur in the North Atlantic right whale critical habitat area at any time of the year. The critical habitat area is used on occasion for post maintenance operational checks and equipment testing due to its proximity to shore. Unless otherwise dictated by national security needs, the Navy will minimize helicopter dipping sonar maintenance within the southeast North Atlantic right whale critical habitat from November 15 to April 15.

- Object Detection Exercises in North Atlantic right whale Critical Habitat
  - ◦ Object detection training requirements are another type of activity that have been identified as planned to occur in the southern North Atlantic right whale critical habitat. The Navy recognizes the significance of the North Atlantic right whale calving area and has explored ways of affecting the least practicable impact (which includes a consideration of practicality of implementation and impacts to training fidelity) to right whales. Navy units will incorporate data from the Early Warning System (EWS) into exercise pre-planning efforts. USFF contributes more than $150,000 annually for aerial surveys that support the EWS, a communication network that assists afloat commands to avoid interactions with right whales. Fleet Area Control and Surveillance Facility, Jacksonville (FACSFAC JAX) houses the Whale Fusion Center, which disseminates the latest right whale sighting information to Navy ships, submarines, and aircraft. Through the Fusion Center, FACSFAC JAX coordinates ship and aircraft movement into the right whale critical habitat and the surrounding operating areas based on season, water temperature, weather conditions, and frequency of whale sightings and provides right whale reports to ships, submarines and aircraft, including coast guard vessels and civilian shipping. The Navy proposes to:
  - ◦ Reduce the time spent conducting object detection exercises in the North Atlantic right whale critical habitat.
  - ◦ Prior to conducting surface ship object detection exercises in the southeast North Atlantic right whale critical habitat during the time of November 15 to April 15, ships will contact FACSFAC JAX to obtain the latest right whale sighting information. FACSFAC JAX will advise ships of all reported whale sightings in the vicinity of the critical habitat and Associated Area of Concern. To the extent operationally feasible,

ships will avoid conducting training in the vicinity of recently sighted right whales. Ships will maneuver to maintain at least 457 m (500 yd) separation from any observed whale, consistent with the safety of the ship.

5.1.4 Coordination and Reporting

The Navy would coordinate with NMFS Stranding Coordinators for any unusual marine mammal behavior. This includes any stranding, beached live/dead, or floating marine mammals that may occur coincident with Navy training activities.

These mitigation measures have been developed in full consideration of the recommendations of the joint National Oceanic and Atmospheric Administration (NOAA) / Navy report on the Bahamas marine mammal stranding event (Department of Commerce [DOC] and Department of the Navy [DON], 2001).

5.2 MITIGATION MEASURES RELATED TO EXPLOSIVE SOURCE SONOBUOYS (AN/SSQ-110A)

- Crews will conduct visual reconnaissance of the drop area prior to laying their intended sonobuoy pattern. This search should be conducted below 457 m (500 yd) at a slow speed, if operationally feasible and weather conditions permit. In dual aircraft operations, crews may conduct coordinated area clearances.
- Crews shall conduct a minimum of 30 minutes of visual and aural monitoring of the search area prior to commanding the first post (source/receiver sonobuoy pair) detonation. This 30-minute observation period may include pattern deployment time.
- For any part of the briefed pattern where a post will be deployed within 914 m (1,000 yd) of observed marine mammal activity, crews will deploy the receiver ONLY and monitor while conducting a visual search. When marine mammals are no longer detected within 914 m (1,000 yd) of the intended post position, crews will co-locate the explosive source sonobuoy (AN/SSQ-110A) (source) with the receiver.
- When operationally feasible, crews will conduct continuous visual and aural monitoring of marine mammal activity, including monitoring of their aircraft sensors from first sensor placement to checking off-station and out of RF range of these sensors.
- Aural Detection:
  - Aural detection of marine mammals cues the aircrew to increase the diligence of their visual surveillance.
  - If, following aural detection, no marine mammals are visually detected, then the crew may continue active search.
- Visual Detection:
  - If marine mammals are visually detected within 914 m (1,000 yd) of the explosive source sonobuoy (AN/SSQ-110A) intended for use, then that payload shall not be

detonated. Aircrews may utilize this post once the marine mammals have not been re-sighted for 30 minutes, or are observed to have moved outside the 914 m (1,000 yd) safety zone.

  - Aircrews may shift their active search to another post, where marine mammals are outside the 914 m (1,000 yd) safety zone.

- Aircrews shall make every attempt to manually detonate the unexploded charges at each post in the pattern prior to departing the operations area by using the "Payload 1 Release" command followed by the "Payload 2 Release" command. Aircrews shall refrain from using the "Scuttle" command when two payloads remain at a given post. Aircrews will ensure a 914 m (1,000 yd) safety zone, visually clear of marine mammals, is maintained around each post as is done during active search operations.
- Aircrews shall only leave posts with unexploded charges in the event of a sonobuoy malfunction, an aircraft system malfunction, or when an aircraft must immediately depart the area due to issues such as fuel constraints, inclement weather, and in-flight emergencies. In these cases, the sonobuoy will self-scuttle using the secondary or tertiary method.
- Aircrews ensure all payloads are accounted for. Sonobuoys that can not be scuttled shall be reported as unexploded ordnance via voice communications while airborne and, upon landing via naval message.
- Mammal monitoring shall continue until out of their aircraft sensor range.

5.3 MITIGATION MEASURES RELATED TO VESSEL TRANSIT AND NORTH ATLANTIC RIGHT WHALES

In 1999, a Mandatory Ship Reporting System was implemented by the U.S. Coast Guard, which requires vessels larger than 300 gross registered tons (DON ships are exempt) to report their location, course, speed, and destination upon entering the nursery and feeding areas of the right whale. At the same time, ships receive information on locations of right whale sightings, in order to avoid collisions with the animals. In the southeastern United States, the reporting system is from November 15 through April 15 of each year; the geographical boundaries include coastal waters within roughly 46 kilometers (km) (25 nautical miles [NM]) of shore along a 167 km (90 NM) stretch of the Atlantic coast in Florida and Georgia. In the northeastern United States, the reporting system is year-round and the geographical boundaries include the waters of Cape Cod Bay, Massachusetts Bay, and the Great South Channel east and southeast of Massachusetts; it includes all of Stellwagen Bank National Marine Sanctuary. A portion of the Boston OPAREA falls within these boundaries. Specific naval mitigation measures for each region of the AFAST Study Area are discussed in the following subsections.

5.3.1 Mid-Atlantic, Offshore of the Eastern United States

For purposes of these measures, the mid-Atlantic is defined broadly to include ports south and east of Block Island Sound southward to South Carolina. The procedure described below would be established as mitigation measures for Navy vessel transits during Atlantic right whale migratory seasons near ports located off the western North Atlantic, offshore of the eastern United States. The mitigation measures would apply to all Navy vessel transits, including those vessels that would transit to and from East Coast ports and OPAREAs. Seasonal migration of right whales is generally described by NMFS as occuring from October 15th through April 30th, when right whales migrate between feeding grounds farther north and calving grounds farther south. The Navy mitigation measures have been established in accordance with rolling dates identified by NMFS consistent with these seasonal patterns.

NMFS has identifed ports located in the western Atlantic Ocean, offshore of the southeastern United States, where vessel transit during right whale migration is of highest concern for potential ship strike. The ports include the Hampton Roads entrance to the Chesapeake Bay, which includes the concentration of Atlantic Fleet vessels in Norfolk, Virginia. Navy vessels are required to use extreme caution and operate at a slow, safe speed consistent with mission and safety during the months indicated in Table 5-1 and within a 37 kilometer (km) (20 nautical mile [NM]) arc (except as noted) of the specified reference points.

During the indicated months, Navy vessels would practice increased vigilance with respect to avoidance of vessel-whale interactions along the mid-Atlantic coast, including transits to and from any mid-Atlantic ports not specifically identified above. All surface(d) units transiting within 56 km (30 NM) of the coast in the mid-Atlantic would ensure at least two watchstanders are posted, including at least one lookout that has completed required MSAT training. Furthermore, Navy vessels would not knowingly approach any whale head on and would maneuver to keep at least 457 m (500 yd) away from any observed whale, consistent with vessel safety.

Table 5-1. Locations and Time Periods When Navy Vessels Are Required to Reduce Speeds (Relevant to North Atlantic Right Whales)

Region	Months	Port Reference Points
South and East of Block Island	Sep–Oct and Mar–Apr	37 km (20 NM) seaward of line between 41-4.49N 071-51.15W and 41-18.58N 070-50.23W
New York / New Jersey	Sep–Oct and Feb-Apr	40-30.64N 073-57.76W
Delaware Bay (Philadelphia)	Oct–Dec and Feb–Mar	38-52.13N 075-1.93W
Chesapeake Bay (Hampton Roads and Baltimore)	Nov-Dec and Feb–Apr	37-1.11N 075-57.56W
North Carolina	Dec–Apr	34-41.54N 076-40.20W
South Carolina	Oct–Apr	33-11.84N 079-8.99W 32-43.39N 079-48.72W

5.3.2 Southeast Atlantic, Offshore of the Eastern United States

For purposes of these measures, the southeast encompasses sea space from Charleston, South Carolina, southward to Sebastian Inlet, Florida, and from the coast seaward to 148 km (80 NM) from shore. The mitigation measures described in this section were developed specifically to protect the North Atlantic right whale during its calving season (Typically from December 1 through March 31). During this period, North Atlantic right whales give birth and nurse their calves in and around a federally designated critical habitat off the coast of Georgia and Florida.

This critical habitat is the area from 31-15N to 30-15N extending from the coast out to 28 km (15 NM), and the area from 28-00N to 30-15N from the coast out to 9 km (5 NM). All mitigation measures that apply to the critical habitat also apply to an associated area of concern which extends 9 km (5 NM) seaward of the designated critical boundaries.

Prior to transiting or training in the critical habitat or associated area of concern, ships will contact Fleet Area Control and Surveillance Facility, Jacksonville, to obtain latest whale sighting and other information needed to make informed decisions regarding safe speed and path of intended movement. Subs shall contact Commander, Submarine Group Ten for similar information.

Specific mitigation measures related to activities occurring within the critical habitat or associated area of concern include the following:

- When transiting within the critical habitat or associated area of concern, vessels will exercise extreme caution and proceed at a slow safe speed. The speed will be the slowest safe speed that is consistent with mission, training and operations.
- Speed reductions (adjustments) are required when a whale is sighted by a vessel or when the vessel is within 9 km (5 NM) of a reported new sighting less than 12 hours old.
- Additionally, circumstances could arise where, in order to avoid North Atlantic right whale(s), speed reductions could mean vessel must reduce speed to a minimum at which it can safely keep on course or vessels could come to an all stop.
- Vessels will avoid head-on approach to North Atlantic right whale(s) and will maneuver to maintain at least 457 m (500 yd) of separation from any observed whale if deemed safe to do so. These requirements do not apply if a vessel's safety is threatened, such as when change of course would create an imminent and serious threat to person, vessel, or aircraft, and to the extent vessels are restricted in the ability to maneuver.
- Ships shall not transit through the critical habitat or associated area of concern in a North-South direction.
- Ship, surfaced subs, and aircraft will report any whale sightings to Fleet Area Control and Surveillance Facility, Jacksonville, by most convenient and fast means. Sighting report will include the time, latitude/longitude, direction of movement and number and description of whale (i.e., adult/calf).

5.3.3 Northeast Atlantic, Offshore of the Eastern United States

The protective measures described in this section apply to aircraft operating in the Boston OPAREA (Warning Areas W-102, W-103, and W-104), as well as ships operating within the entire Atlantic Fleet area of responsibility (AOR), except those areas off the southeastern U.S. already covered in Sections 5.3.1 and 5.3.2.

Prior to transiting the Great South Channel or Cape Cod Bay critical habitat areas, ships will obtain the latest right whale sightings and other information needed to make informed decisions regarding safe speed. The Great South Channel critical habitat is defined by the following coordinates: 41-00N, 69-05W; 41-45N, 69-45W; 42-10N, 68-31W; 41-38N, 68-13W. The Cape Cod Bay critical habitat is defined by the following coordinates: 42-04.8N, 70-10W; 42-12N, 70-15W; 42-12N, 70-30W; 41-46.8N, 70-30W.

Ships, surfaced subs, and aircraft will report any North Atlantic right whale sightings (if the whale is identifiable as a right whale) off the northeastern U.S. to Patrol and Reconnaissance Wing (COMPATRECONWING). The report will include the time of sighting, lat/long, direction of movement (if apparent) and number and description of the whale(s). In addition, vessels or aircraft that observe whale carcasses will record the location and time of the sighting and report this information as soon as possible to the cognizant regional environmental coordinator. All whale strikes must be reported. Report will include the date, time, and location of the strike; vessel course and speed; operations being conducted by the vessel; weather conditions, visibility, and sea state; description of the whale; narrative of incident; and indication of whether photos/videos were taken. Units are encouraged to take photos whenever possible.

Specific mitigation measures related to activities occurring within the critical habitat or associated area of concern include the following:

- Vessels will avoid head-on approach to North Atlantic right whale(s) and will maneuver to maintain at least 457 m (500 yd) of separation from any observed whale if deemed safe to do so. These requirements do not apply if a vessel's safety is threatened, such as when change of course would create an imminent and serious threat to person, vessel, or aircraft, and to the extent vessels are restricted in the ability to maneuver.
- When transiting within the critical habitat or associated area of concern, vessels shall use extreme caution and operate at a safe speed so as to be able to avoid collisions with North Atlantic right whales and other marine mammals, and stop within a distance appropriate to the circumstances and conditions.
- Speed reductions (adjustments) are required when a whale is sighted by a vessel or when the vessel is within 9 km (5 NM) of a reported new sighting less than one week old.
- Ships transiting in the Cape Cod Bay and Great South Channel critical habitats will obtain information on recent whale sightings in the vicinity of the critical habitat. Any vessel operating in the vicinity of a North Atlantic right whale shall consider additional speed reductions as per Rule 6 of International Navigational Rules.

Additional Mitigation for Torpedo Exercises (TORPEXs) in the Northeast North Atlantic right whale Critical Habitat. TORPEXs in locations other than the Northeast will utilize the measures described in Section 5.1. TORPEXs conducted in the five TORPEX training areas off of Cape Cod, which may occur in right whale critical habitat, will implement the following measures:

- All torpedo-firing operations shall take place during daylight hours.
- During the conduct of each test, visual surveys of the test area shall be conducted by all vessels and aircraft involved in the exercise to detect the presence of marine mammals. Additionally, trained observers shall be placed on the submarine, spotter aircraft, and the surface support vessel. All participants will be required to report sightings of any marine mammals, including negative reports, prior to torpedo firings. Reporting requirements

will be outlined in the test plans and procedures written for each individual exercise, and will be emphasized as part of pre-exercise briefings conducted with all participants.

- Observers shall receive NMFS-approved training in field identification, distribution, and relevant behaviors of marine mammals of the western north Atlantic. Currently, this training is provided by a professor at the University of Rhode Island, Graduate School of Oceanography. Observers shall fill out Standard Sighting Forms and the data will be housed at the Naval Undersea Warfare Center Division Newport (NUWCDIVNPT). Any sightings of North Atlantic right whales shall be immediately communicated to the Sighting Advisory System (SAS). All platforms shall have onboard a copy of the following:
  - The Guide to Marine Mammals and Turtles of the U.S. Atlantic and Gulf of Mexico (Wynne and Schwartz 1999).
  - The NMFS Critical Sightings Program placard.
  - Right Whales, Guidelines to Mariners placard.
- In addition to the visual surveillance discussed above, dedicated aerial surveys shall be conducted utilizing a fixed-wing aircraft. An aircraft with an overhead wing (i.e., Cessna Skymaster or similar) will be used to facilitate a clear view of the test area. Two trained observers, in addition to the pilot, shall be embarked on the aircraft. Surveys will be conducted at an approximate altitude of 305 m (1,000 feet [ft]) flying parallel track lines at a separation of 1.85 km (1 NM), or as necessary to facilitate good visual coverage of the sea surface. While conducting surveillance, the aircraft shall maintain an approximate speed of 185 kilometers per hour (km/hr) (100 knots [kn]). Since factors that affect visibility are highly dependent on the specific time of day of the survey, the flight operator will have the flexibility to adjust the flight pattern to reduce glare and improve visibility. The entire test site will be surveyed initially, but once preparations are being made for an actual test launch, survey effort will be concentrated over the vicinity of the individual test location. Further, for approximately ten minutes immediately prior to launch, the aircraft will racetrack back and forth between the launch vessel and the target vessel.
- Commencement of an individual torpedo test scenario shall not occur until observers from all vessels and aircraft involved in the exercise have reported to the Officer in Tactical Command (OTC) and the OTC has declared that the range is clear of marine mammals. Should protected animals be present within or seen moving toward the test area, the test shall be either delayed or moved as required to avoid interference with the animals.
- The TORPEX will be suspended if the Beaufort Sea State exceeds 3 or if visibility precludes safe operations.
- Vessel speeds:
  - During transit through the North Atlantic right whale critical habitat, surface vessels and submarines shall maintain a speed of no more than 19 km/hr (10 kn) while not actively engaged in the exercise procedures.
  - During TORPEX operations, a firing vessel will likely not exceed 19 km/hr (10 kn). When a submarine is used as a target, vessel speeds would not likely exceed 33 km/hr

(18 kn). However, on occasion, when surface vessels are used as targets, the vessel may exceed 33 km/hr (18 kn) in order to fully test the functionality of the torpedoes. This increased speed would occur for a short period of time (e.g., 10 to 15 minutes) to evade the torpedo when fired upon.

- In the event of an animal strike, or if an animal is discovered that appears to be in distress, a report will immediately be promulgated through the appropriate Navy chain of Command (see Stranding Plan in NMFS Final Rule for additional details).

5.4 DETECTION PROBABILITY AND MITIGATION EFFICACY

5.4.1 Factors Affecting Detection Probability

The probability of visually detecting a marine animal is dependent upon two things. First, the animal and the observer must be in the same place at the same time. If the animal is not present, it cannot be seen (availability bias) (Marsh and Sinclair, 1989). Second, when the animal is in a position to be detected by an observer and the observer in a position to detect the animal, the observer must perceive the animal (perception bias) (Marsh and Sinclair, 1989). The factors affecting the detection of the animal may be probabilistically quantified as *g(0)*. That is, *g(0)* represents the chance that the animal will be available for detection (i.e., on the surface and in the observer's field of view) and that the observer will perceive the animal. A *g(0)* value of 1 indicates that 100 percent of the animals are detected; it is rare that this assumption holds true, as both perception and availability bias impact the overall value of *g(0)* for any given species.

Various factors are involved in estimating *g(0)*, including: sightability/detectability of the animal (species-specific behavior and appearance, school size, blow characteristics, dive characteristics, and dive interval); viewing conditions (sea state, wind speed, wind direction, sea swell, and glare); and observer (experience, fatigue, and concentration) and platform characteristics (pitch, roll, yaw, speed, and height above water). Thomsen et al. (2005) provide a complete and recent discussion of *g(0)*, factors that affect the detectability of the animals, and ideas on how to account for detection bias. Table 5-2 provides a range of values for *g(0)* for cetacean species in the AFAST Study Area. It is important to note that *g(0)* as it is used here does not relate to the ability to identify an animal on any order, only that the animal will be detected.

5.4.1.1 Marine Mammals

There are many variables that play into how easily a marine mammal may be detected by an observer at the surface [i.e., the g(*0*) value for that species]. As discussed previously, some of these variables affect (or are affected by) the observer, the platform, and the conditions under which the observations are being made. Many of the variables, however, are directly related to the animal, its external appearance, its behavior and its life history. The size of the animal, its surface behavior, its dive behavior, and the overall gregariousness of the species all impact the ability of the observer to detect an individual(s) at the surface.

In addition to (or in lieu of) visual detection, some species may be detected acoustically. This type of detection for AFAST operations is limited to species that (1) vocalize commonly and (2) vocalize within the range of human hearing. Acoustic information, including how frequently or in what range a species may vocalize, is not available for all species. However, species that most likely will or most likely will not be detected acoustically are noted below.

The following is a much generalized discussion of the behavior and external appearance of the marine mammals with the potential to occur in the AFAST Study Area as these characters relate to the detectability of each species. The species are grouped loosely based on either taxonomic relatedness or commonalities in size and behavior (or both). Not all statements may hold true for all species in a grouping and outstanding exceptions are mentioned where applicable. The information presented in this section may be found in Jefferson et al. (2008) and sources within unless otherwise noted.

5.4.1.1.1 Cetaceans

Large Whales

Species of large whales found in the AFAST Study Area include all the baleen whales and the sperm whale. Baleen whales are generally large (adult size ranging from 9 to 27 m [30 to 89 ft]), often making them immediately detectable. Many species of baleen whales have a prominent blow ranging from 3 m (10 ft) to as much as 12 m (39 ft) above the surface. However, there are at least two species (Bryde's whale and common minke whale) that often have no visible blow. Baleen whales tend to travel singly or in small groups ranging from pairs to groups of five; the exception to this is the fin whale, which is known to travel in pods of seven or more individuals. However, all species of baleen whales are known to form larger-scale aggregations in areas of high localized productivity or on breeding grounds. Baleen whales may or may not fluke at the surface before they dive; some species fluke regularly (humpback whale, North Atlantic right whale), some fluke variably (blue whale, fin whale) and some rarely fluke (sei whale, common minke whale, and Bryde's whale). Baleen whales may remain at the surface for extended periods of time as they forage or socialize. North Atlantic right whales are known to form surface-active groups (SAG) and humpback whales to corral prey at the surface. Dive behavior varies amongst species, as well. Many species will dive and remain at depth for as long as 30 minutes. Some will adjust their diving behavior according to the presence of vessels (North Atlantic right whale, humpback whale, fin whale). Sei whales are known to sink just below the surface and remain there between breaths. Baleen whales have *g(0)* values ranging from 0.11 to 1.00 (Table 5-2).

Sperm whales also belong to the large whales, with adult males reaching as much as 18 m (50 ft) in total length. Sperm whales at the surface would likely be easy to detect. They are large, have a prominent, 5 m (16 ft) blow, and may remain at the surface for long periods of time. They are known to raft (i.e., loll at the surface) and to form SAGs when socializing. Sperm whales may travel or congregate in large groups of as many as 50 individuals. They also engage in conspicuous surface behavior such as fluking, breaching and tail-slapping. However, sperm whales are long, deep divers and may remain submerged for over an hour. Sperm whales vocalize frequently (Teloni, 2005) and would probably be detected acoustically. Sperm whales have *g(0)* values ranging from 0.19 to 1.00 (Table 5-2).

Cryptic Species

Cryptic cetacean species are those that are known to be difficult to detect on the surface or that actively avoid vessels. These include beaked whales (family Ziphiidae), dwarf and pygmy sperm whales (*Kogia* spp.), and harbor porpoises.

Beaked whales are notoriously difficult to detect at sea. Beaked whales may occur in a variety of group sizes, ranging from single individuals to groups of as many as 100 (MacLeod and D'Amico, 2006). For beaked whale species occurring in the AFAST Study Area, group sizes may range from 1 to 22 individuals. Beaked whale diving behavior in general consists of long, deep dives that may last for nearly 90 minutes followed by a series of shallower dives and intermittent surfacings (Tyack et al., 2006; Baird et al., 2007). However, individuals may remain at the surface for an extended period of time (perhaps an hour or more) or make shorter dives (MacLeod and D'Amico, 2006). Detection of beaked whales is further complicated because beaked whales often dive and surface in a synchronous pattern (MacLeod and D'Amcio, 2006) and they travel below the surface of the water. Beaked whales are odontocetes and use acoustic signals for communication and foraging. They are known to produce sounds ranging from low to high frequency (MacLeod and D'Amico, 2006). However, many of the sounds that have been recorded for beaked whales fall at or outside the upper range of human hearing (greater than 20 kHz), making acoustic detection less likely for these species than for species with a lower peak frequency. Beaked whales have *g(0)* values ranging from 0.13 to 1.00 (Table 5-2).

Dwarf and pygmy sperm whales (referred to broadly as *Kogia* spp.) are small cetaceans (3 to 4 m [10 to 13 ft] adult length) that are not seen commonly at sea. *Kogia* spp. are some of the most commonly stranded species in some areas, which suggests that sightings are not indicative of their overall abundance. This supports the idea that they are cryptic, perhaps engaging in inconspicuous surface behavior or actively avoiding vessels. When *Kogia* spp. are sighted, they are seen in groups of no more than five to six individuals. They have no visible blow, do not fluke when they dive, and are known to log (i.e., lie motionless) at the surface. When they do dive, they often will sink out of sight with no prominent behavioral display. There is little acoustic information on *Kogia* spp.; what is available suggests that *Kogia* spp. emit ultrasonic clicks with a peak frequency of 125 kHz (Marten, 2000), well outside of what is audible to the human ear. *Kogia* spp. are not likely to be detected acoustically. *Kogia* spp. have *g(0)* values ranging from 0.19 to 0.79 (Table 5-2).

Harbor porpoises are better known than beaked whales and *Kogia* spp., but are considered to be cryptic because they are difficult to detect in all but the best of conditions (i.e., no swell, no whitecaps). Harbor porpoises travel singly or in small groups (less than six individuals), but may aggregate into groups of several hundred. They are inconspicuous at the surface, rarely lifting their heads above the surface and often lying motionless. They are small and may actively avoid vessels. Harbor porpoises have *g(0)* values ranging from 0.08 to 0.85 (Table 5-2).

Delphinids

There are 18 species of the family Delphinidae that may occur in the AFAST Study Area. There are a variety of factors that make these species some of the most likely to be detected at sea by observers. Many species of delphinids engage in very conspicuous surface behavior, including leaping, spinning, bow riding, and traveling along the surface in large groups. Delphinid group sizes may range from 10 to 10,000 individuals, depending upon the species and the geographic region. Species such as pilot whales, rough-toothed dolphins, white-beaked dolphins, white-sided dolphins, bottlenose dolphins, Stenellid dolphins, common dolphins, and Fraser's dolphins are known to either actively approach and investigate vessels, or bow ride along moving vessels. Fraser's dolphins and common dolphins form huge groups that travel quickly along the surface, churning up the water and making them visible from a great distance. Delphinids may dive for as little as a minute to over thirty minutes, depending upon the species. Some species of delphinids are very vocal and may be easily detected acoustically if they are foraging or socializing. There are records of some species of Delphinids (spinner dolphins, pantropical spotted dolphins, common dolphins) actively avoiding vessels in the Eastern Tropical Pacific (ETP). This behavior is probably a response to the high levels of mortality associated with tuna fisheries in the ETP and has not been noted elsewhere in the world. Delphinids have *g(0)* values ranging from 0.19 to 1.00, with many species having much higher values.

Miscellaneous

Beluga whales may occur in the AFAST Study Area and would probably be detected by observers. Belugas have an extremely conspicuous coloration (all white) and reach up to 5 m (16 ft) in total length. They travel in groups ranging from 15 individuals to thousands. They dive for lengths of up to 25 minutes, but are one of the most vocal cetaceans and would likely be detected acoustically. There are no *g(0)* values available for beluga whales.

5.4.1.1.2 Pinnipeds

There are no sea lions in North Atlantic waters. Seals are more difficult to detect at sea than cetaceans. They are much smaller, often solitary and generally do not engage in conspicuous surface behavior. There is not a lot of information regarding seal behavior at sea. Some species, such as harbor seals, are known to approach and observe human activities on land or on stationary vessels. Harbor seals and gray seals are solitary at sea. Harp seals appear to be an exception, traveling in large groups at the surface and churning up whitewater like dolphins. Gray seals are known to rest vertically at the surface with only the head exposed. Pinnipeds may be long divers; gray seals may dive for as long as 30 minutes and hooded seals for up to 60 minutes. The only *g(0)* values available for pinnipeds occurring in the AFAST Study Area are for the harbor seal. They have a *g(0)* value of 0.28.

Table 5-2. Range of Estimates for g(0) for Marine Mammal Species Found in the AFAST Study Area

g(0)[1]	Location	Platform	Source
Threatened/Endangered Cetacean Species			
Right whale (*Eubalaena* spp.)			
0.29-1.00	U.S. Atlantic Coast	Shipboard	(Palka, 2006)
0.11-0.71	U.S. Atlantic Coast	Aerial	(Hain et al., 1999)
0.19-0.29	U.S. Atlantic Coast	Aerial	(Palka, 2005b)
0.95	U.S. West Coast	Aerial	(Forney et al., 1995)
Humpback (*Megaptera novaeangliae*)			
0.19-0.21	U.S. Atlantic Coast	Shipboard	(Palka, 2005a)
0.90-1.00	U.S. West Coast	Shipboard	(Barlow 1995; Calambokidis and Barlow, 2004)
0.95	U.S. West Coast	Aerial	(Forney et al., 1995)
0.26	Hawaii	Aerial	(Mobley et al., 2001)
Blue whale (*Balaenoptera musculus*)			
0.41	U.S. West Coast	Aerial	(Barlow et al., 1997; Carretta, et al. 2000)
0.9-1.00	U.S. West Coast	Shipboard	(Barlow and Taylor, 2001)
0.92	U.S. West Coast	Shipboard	(Barlow and Forney, 2007; Forney 2007)
Sei whale (*Balaenoptera borealis*)			
0.92	U.S. West Coast	Shipboard	(Barlow and Forney, 2007; Forney 2007)
Fin whale (*Balaenoptera physalus*)			
0.32-0.94	U.S. Atlantic Coast	Shipboard	(Blaylock et al., 1995; Palka, 2006)
0.19-0.29	U.S. Atlantic Coast	Aerial	(Palka, 2005b)
0.90-1.00	U.S. West Coast	Shipboard	(Barlow, 1995, 2003a)
0.95-0.98	U.S. West Coast	Aerial	(Forney and Barlow, 1993; Forney et al. 1995)
0.90-1.00	Hawaii	Shipboard	(Barlow, 2003b)
Sperm whale (*Physeter macrocephalus*)			
0.28-0.57	U.S. Atlantic Coast	Shipboard	(Palka, 2005a; Palka, 2006)
0.19-0.29	U.S. Atlantic Coast	Aerial	(Palka, 2005b)
0.53-1.00	U.S. West Coast	Shipboard	(Barlow, 1995; Barlow and Gerrodette, 1996; Barlow and Sexton, 1996; Barlow, 2003a; Barlow and Taylor, 2005)
0.95-0.98	U.S. West Coast	Aerial	(Forney and Barlow, 1993; Forney et al., 1995)
0.87	Hawaii	Shipboard	(Barlow, 2003b, 2006)
0.32	Antarctic	Shipboard	(Kasamatsu and Joyce, 1995)
Non-Threatened/Non-Endangered Cetacean Species			
Minke whale (*Balaenoptera acutorostrata*)			
0.31-0.70	U.S. Atlantic Coast	Shipboard	(Blaylock et al., 1995; Palka, 2006)
0.19-0.29	U.S. Atlantic Coast	Aerial	(Palka, 2005b)

Table 5-2. Range of Estimates for g(0) for Marine Mammal Species Found in the AFAST Study Area Cont'd

g(0)[1]	Location	Platform	Source
Non-Threatened/Non-Endangered Cetacean Species			
Minke whale (*Balaenoptera acutorostrata*) Cont'd			
0.25-0.90	Eastern North Atlantic	Shipboard	(Butterworth and Borchers ,1988; Øien, 1990; Schweder et al., 1991; Schweder and Høst, 1992; Schweder et al., 1992; Schweder et al., 1997; Skaug and Schweder, 1999; Skaug et al., 2004)
0.84	U.S. West Coast	Shipboard	(Barlow, 1995, 2003a)
0.95-0.98	U.S. West Coast	Aerial	(Forney and Barlow, 1993; Forney et al., 1995)
0.63-0.83	Antarctic	Shipboard	(Doi et al., 1982; IWC, 1982, 1983)
Bryde's whale (*Balaenoptera edeni*)			
0.90-1.00	U.S. West Coast	Shipboard	(Barlow, 1995, 2003a)
0.90	Hawaii	Shipboard	(Barlow, 2003b, 2006)
Beluga (*Delphinapterus leucas*)			
None available.			
***Kogia* spp.**			
0.29-0.55	U.S. Atlantic Coast	Shipboard	(Palka, 2006)
0.19-0.79	U.S. West Coast	Shipboard	(Barlow, 1995; Barlow and Sexton, 1996; Barlow, 1999, 2003a)
0.35	Hawaii	Shipboard	(Barlow, 2003b, 2006)
Ziphiidae (Beaked Whales)			
0.46-0.51	U.S. Atlantic Coast	Shipboard	(Palka, 2005a; Palka 2006)
0.19-0.21	U.S. Atlantic Coast	Aerial	(Palka, 2005b)
0.13-1.00	U.S. West Coast	Shipboard	(Barlow, 1995; Barlow and Sexton, 1996; Barlow, 1999; Carretta et al., 2001; Barlow, 2003a; Barlow, et al. 2006)
0.23-0.45	Hawaii	Shipboard	(Barlow, 2003b, 2006)*
0.27	Antarctic	Shipboard	(Kasamatsu and Joyce, 1995)
0.95-0.98	U.S. West Coast	Aerial	(Forney and Barlow, 1993; Forney et al., 1995)
Bottlenose dolphin (*Tursiops truncatus*)			
0.62-0.99	U.S. Atlantic Coast	Shipboard	(Palka, 2005a; Palka, 2006)
0.58-0.77	U.S. Atlantic Coast	Aerial	(Palka, 2005b)
0.74-1.00	U.S. West Coast	Shipboard	(Barlow, 1995, 2003a)
0.67-0.96	U.S. West Coast	Aerial	(Forney and Barlow, 1993; Forney et al., 1995)
0.74-1.00	Hawaii	Shipboard	(Barlow, 2003b, 2006)
Spinner dolphin (*Stenella longirostris*)			
0.61-0.76	U.S. Atlantic Coast	Shipboard	(Palka, 2006)
0.77-1.0	U.S. West Coast	Shipboard	(Barlow, 2003a)
0.77-1.0	Hawaii	Shipboard	(Barlow, 2003b, 2006)

Table 5-2. Range of Estimates for g(0) for Marine Mammal Species Found in the AFAST Study Area Cont'd

g(0)[1]	Location	Platform	Source
Non-Threatened/Non-Endangered Cetacean Species			
Clymene dolphin (*Stenella clymene*)			
None available.			
Pantropical spotted dolphin (*Stenella attenuata*)			
0.37-0.94	U.S. Atlantic Coast	Shipboard	(Palka, 2006)*
0.77-1.00	U.S. West Coast	Shipboard	(Barlow, 2003a)
0.76-1.00	Hawaii	Shipboard	(Barlow, 2003b, 2006)
Atlantic spotted dolphin (*Stenella frontalis*			
0.37-0.94	U.S. Atlantic Coast	Shipboard	(Palka, 2006)**
Striped dolphin (*Stenella coeruleoalba*)			
0.61-0.77	U.S. Atlantic Coast	Shipboard	(Palka, 2005a; Palka, 2006)
0.77-1.00	U.S. West Coast	Shipboard	(Barlow, 1995, 2003a)
0.76-1.00	Hawaii	Shipboard	(Barlow, 2003b, 2006)
Common dolphin (*Delphinus delphis*)			
0.52-0.95	U.S. Atlantic Coast	Shipboard	(Palka, 2005a; Palka, 2006)
0.58-0.77	U.S. Atlantic Coast	Aerial	(Palka, 2005b)
0.79-0.81	Eastern North Atlantic	Shipboard	(Cañadas et al., 2004)
0.77-1.0	U.S. West Coast	Shipboard	(Barlow, 1995, 2003a)
0.67-0.96	U.S. West Coast	Aerial	(Forney and Barlow, 1993; Forney et al., 1995)
Rough-toothed dolphin (*Steno bredanensis*)			
0.74-1.00	U.S. West Coast	Shipboard	(Barlow, 2003a)
0.74-1.00	Hawaii	Shipboard	(Barlow, 2003b, 2006)
Fraser's dolphin (*Lagenodelphis hosei*)			
0.76-1.00	Hawaii	Shipboard	(Barlow, 2003b, 2006)
White-sided dolphin (*Lagenorhynchus acutus and L. obliquidens*)			
0.27-0.38	U.S. Atlantic Coast	Shipboard	(Palka, 2006)
0.58-0.77	U.S. Atlantic Coast	Aerial	(Palka, 2005b)
0.77-1.00	U.S. West Coast	Shipboard	(Barlow, 1995, 2003a)
0.67-0.96	U.S. West Coast	Aerial	(Forney and Barlow, 1993; Forney et al., 1995)
White-beaked dolphin (*Lagenorhynchus albirostris*)			
None available.			
Risso's dolphin (*Grampus griseus*)			
0.51-0.84	U.S. Atlantic Coast	Shipboard	(Palka, 2005a; Palka 2006)
0.58-0.77	U.S. Atlantic Coast	Aerial	(Palka, 2005b)
0.74-1.00	U.S. West Coast	Shipboard	(Barlow, 1995, 2003a)
0.67-0.96	U.S. West Coast	Aerial	(Forney and Barlow, 1993; Forney et al., 1995)
0.74-1.00	Hawaii	Shipboard	(Barlow, 2003b, 2006)
False killer whale (*Pseudorca crassidens*)			
0.74-1.00	Hawaii	Shipboard	(Barlow, 2003b, 2006)
Pygmy killer whale (*Feresa attenuata*)			
0.74-1.00	Hawaii	Shipboard	(Barlow, 2003b, 2006)
Killer whale (*Orcinus orca*)			
0.90	U.S. West Coast	Shipboard	(Barlow, 2003a)
0.95-0.98	U.S. West Coast	Aerial	(Forney et al., 1995)
0.90	Hawaii	Shipboard	(Barlow, 2003b, 2006)
0.96	Antarctic	Shipboard	(Kasamatsu and Joyce, 1995)

Table 5-2. Range of Estimates for g(0) for Marine Mammal Species Found in the AFAST Study Area Cont'd

g(0)[1]	Location	Platform	Source
Non-Threatened/Non-Endangered Cetacean Species			
Melon-headed whale (*Peponocephala electra*)			
0.74-1.00	Hawaii	Shipboard	(Barlow, 2003b, 2006)
Pilot whale (*Globicephala* spp.)			
0.48-0.67	U.S. Atlantic Coast	Shipboard	(Palka, 2005a; Palka 2006)
0.19-0.29	U.S. Atlantic Coast	Aerial	(Palka, 2005b)
0.74-1.00	U.S. West Coast	Shipboard	(Barlow, 2003a)
Pilot whale (*Globicephala* spp.)			
,0.74-1.00	Hawaii	Shipboard	(Barlow, 2003b, 2006)
0.93	Antarctic	Shipboard	(Kasamatsu and Joyce, 1995)
Harbor porpoise (*Phocoena phocoena*)			
0.35-0.73	U.S. Atlantic Coast	Shipboard	(Palka, 1995; Palka, 1996; Palka, 2006)
0.24-0.49	U.S. Atlantic Coast	Aerial	(Palka, 2005b)
0.41-0.71	Eastern North Atlantic	Aerial	(Grünkorn et al. 2005)
0.08-0.85	U.S. West Coast	Aerial	(Barlow et al. ,1988; Calambokidis et al., 1993a; Forney et al. 1995; Laake et al., 1997; Carretta et al., 2001; Carretta et al., 2007)
0.54-0.79	U.S. West Coast	Shipboard	(Calambokidis et al., 1993b; Barlow 1995; Carretta et al., 2001)
Non-Threatened/Non-Endangered Pinniped Species			
Harbor seal (*Phoca vitulina*)			
.28	U.S. West Coast	Aerial	(Barlow et al., 1997; Carretta ,et al. 2000)

*These numbers were either determined by the source or applied by the source for abundance/density estimation analyses in the particular geographic location.
[1] A *g(0)* value of 1.00 indicates that 100 percent of the animals are detected; it is rare that this assumption holds true. Departures of *g(0)* from 1.00 can be attributed to either perception bias or availability bias.

In general, large whales are fairly easy to detect due to their large size and prominent blow (Taylor et al., 2007). Also relatively easy to detect are large groups of individuals, particularly gregarious delphinids that may be visible from a great distance due to the disturbance they make when moving across the surface of the water. Less easy to detect are marine mammals that spend a great deal of time at depth or whose presence on the surface is solitary and inconspicuous (Taylor et al., 2007).

Most information on pinnipeds is gleaned from studies done while individuals are hauled-out on land or on ice. Systematic at-sea sightings information is limited, so a *g(0)* value is available only for harbor seal (Carretta et al., 2000). Pinnipeds have a low profile, no dorsal appendage and small body size in comparison with most cetaceans, limiting accurate visual detection to sea states of less than Beaufort 2 (Carretta et al., 2000).

It is possible that not all marine mammals will be spotted using visual methods so acoustic methods are often useful for augmenting detection efforts. Most marine mammals produce detectable acoustic signals related to almost every aspect of their life history; in-water acoustic signals are produced mainly by cetaceans, though pinnipeds may make underwater sounds as well (Tyack, 2002). Although acoustic signal production varies depending on the species, age class, gender and behavior (Tyack, 2002), these signals are produced commonly enough to allow detection through passive acoustic monitoring. For example, data suggest that sperm whales do not go longer than 40 minutes without producing some sort of sound (Teloni, 2005; Lewis et al., 2007). Mysticete whales vocalize at lower frequencies than toothed cetaceans. While passive listening will be useful in augmenting visual detection efforts, there are species that either may not produce sound or will not be heard while they are in the vicinity of the detection platform. Many species of toothed whales, including long-diving and cryptic species such as *Kogia* spp. and beaked whales, produce highly directional, ultrasonic sounds (Marten, 2000; Madsen and Wahlberg, 2007). Pinnipeds will not be detected acoustically.

5.4.1.2 Sea Turtles

The detection probability of sea turtles is generally lower than that of cetaceans. Sea turtles often spend over 90 percent of their time underwater (e.g., Byles, 1988; Renaud and Carpenter, 1994; Mansfield and Musick, 2003) and are not visible more than one or two meters below the surface (Mansfield, 2006). Shoop and Kenney (1992) postulated that, due to the dive behavior of sea turtles, marine surveys underestimate the total number of animals in a given area by as much as an order of magnitude. This suggests that standard visual observation efforts may be less effective in detecting sea turtles than they are in detecting cetaceans. Sea turtles also are much smaller than cetaceans, so the effective distance from which they can be seen (from both surface and aerial platforms) is smaller (300 m [984 ft] for turtles versus over a kilometer for large whales or gregarious delphinids; Musick et al., 1984). Shipboard surveys designed for sighting marine mammals are adequate for detecting large sea turtles (e.g., adult leatherbacks) but usually not the smaller-sized turtles (e.g., juveniles, *Lepidochelys* spp.). Pelagic juveniles may be especially difficult to detect. Aerial detection may be more effective in spotting sea turtles on the surface, particularly in calm seas and clear water, but it is possible that the smallest age classes are not detected even in good conditions (Marsh and Saalfeld, 1989). Visual detection of sea turtles, especially small turtles, is further complicated by their startle behavior in the presence of ships. Turtles on the surface may react to the presence of a vessel (dive) before it is detected by shipboard or aerial observers (Kenney, 2005). However, sea turtle reaction time is reduced in proportion to increasing vessel speeds (Hazel et al., 2007).

There have been few dedicated surveys for sea turtles. There is no information available on specific *g(0)* values for turtles. Most of these studies have used mathematical models to calculate the proportion of surfaced turtles to submerged turtles based on the proportion of time sea turtles are expected to spend at the surface (obtained from tracking or tagging data). Byles (1988) found that for every loggerhead observed on the surface in Chesapeake Bay, approximately 19 were present but unobservable. Mansfield (2006) found that sea turtles spent more time at the surface during the spring than during the summer within the Chesapeake Bay. Therefore, the 1:19 (at surface/ under the surface) ratio would change depending on the season. However, sea turtles only spend a portion of the year in Chesapeake Bay and their surfacing behavior may be different than that of year-round residents in other locations. Not only are there no specific estimates of *g(0)* for turtles, but it is likely that the value shifts significantly depending on species, age class, season and geographic region.

Visual mitigation efforts for sea turtles will probably detect only those individuals that are very large or that spend a significant portion of their time at the surface. Sea turtles will not be detected acoustically.

5.4.2 Navy Research Efforts

No mitigation effort will be 100 percent effective, just as no scientific survey is able to detect every animal. It is possible that some species, particularly those that are deep-diving or cryptic, may not be detected by either visual or passive acoustic means during AFAST active sonar activities. In order to address potential impacts to undetected animals, the Navy is coordinating with NMFS to improve mitigation effectiveness.

Evolving and novel approaches in acoustic detection and localization may be useful for mitigation and monitoring. These developing new technologies may help detect marine mammals. The Navy is currently funding a large-scale, behavioral study of beaked whales in the Bahamas to better understand their behavior as it relates to the presence of sound such as mid-frequency active sonar. In addition, the Navy is working to develop the capability to detect and localize vocalizing marine mammals using installed sensors. However, based on the current status of acoustic monitoring science, it is not yet possible to use installed systems as mitigation tools. As this science develops, it will be incorporated in the AFAST mitigation plan.

In addition, the Navy is also actively engaged in acoustic monitoring research involving a variety of methodologies (e.g., underwater gliders); to date, none of the methodologies have been developed to the point where they could be used as an actual mitigation tool. The Navy will continue to coordinate passive monitoring and detection research specific to the proposed use of active sonar. As technology and methodologies become available, their applicability and viability will be evaluated for incorporation into this mitigation plan. Underwater hydrophones such as those associated with underwater instrumented ranges may ultimately be useful in both detecting and localizing marine mammals (Ko et al., 2008).

5.5 CONSERVATION MEASURES

5.5.1 Monitoring

The Navy is committed to demonstrating environmental stewardship while executing its national defense mission and is responsible for compliance with a suite of federal environmental and natural resources laws and regulations that apply to the marine environment. The Navy is developing a number of monitoring plans for protected marine species (primarily marine mammals and sea turtles) as part of the environmental planning and regulatory compliance process associated with a variety of training actions and range complexes. The purpose of these monitoring plans is to assess the effects of training activities on marine species. The primary focus of these monitoring plans will be on effects to individual animals but data may also support investigation of potential population-level trends in marine species distribution, abundance, and habitat use in various range complexes and geographic locations where Navy training occurs.

The Monitoring Plan for AFAST is being developed through the MMPA permitting process in cooperation with NMFS as a collection of focused "studies" to gather data that will allow the Navy to address the following questions:

- Are marine mammals exposed to mid-frequency active sonar, especially at levels associated with adverse effects (i.e., based on NMFS'criteria for behavioral harassment, TTS, or PTS)? If so, at what levels are they exposed?
- If marine mammals are exposed to mid-frequency active sonar in the AFAST study area, do they redistribute geographically as a result of continued exposure? If so, how long does the redistribution last?
- If marine mammals are exposed to mid-frequency active sonar, what are their behavioral responses to various levels?
- Is the Navy's suite of mitigation measures for mid-frequency active sonar effective at avoiding TTS, injury, and mortality of marine mammals?

Data gathered in these studies will be collected by qualified, professional marine mammal biologists that are experts in their field. Monitoring techniques may include the following methods to collect data:

- Visual Surveys – vessel, aerial and shore-based
- Passive acoustic monitoring (PAM)
- Marine mammal observers on Navy vessels
- Marine mammal tagging

While it is not possible to effectively monitor the entire region encompassed by the AFAST Study Area, one method to address the objectives of the monitoring plan is to establish geographically-fixed longitudinal monitoring sites to assess potential effects to marine mammals both at the individual and population level. Two sites have been selected for the establishment of focused monitoring within the AFAST Study Area. The Navy previously contracted with a consortium of researchers from Duke University, the University of North Carolina at Wilmington, the University of St. Andrews, and NMFS Northeast Fisheries Science Center to conduct a pilot study analysis and subsequently develop a survey and monitoring plan that prescribes the recommended approach for data collection including surveys (aerial/shipboard, frequency, spatial extent, etc.), passive acoustic monitoring, photo identification and data analysis (standard line-transect, spatial modeling, etc.) necessary to establish a fine-scale seasonal baseline of protected species distribution and abundance at specific study sites. These baseline studies will provide the foundation for establishing a monitoring program designed to provide meaningful data on potential long term effects to marine species that may be chronically exposed to training activities. Baseline data collection began in June 2007 off the coast of North Carolina in Onslow Bay (a Undersea Warfare Training Range [USWTR] alternative site) and includes coordinated aerial, shipboard, and passive acoustic surveys as well as deployment of HARPs to supplement the traditional visual surveys. A parallel program is currently being initiated off the coast of Jacksonville, Florida (the USWTR preferred site) that will use the same combination of monitoring techniques. Field work at the Jacksonville location is planned to begin in January 2009. Both locations will provide valuable baseline data and serve as a reference for conducting additional monitoring specific to AFAST activities.

In addition to the Monitoring Plan for AFAST, the Navy is developing an Integrated Comprehensive Monitoring Process (ICMP). The ICMP will provide the overarching coordination that will support compilation of data from individual monitoring plans (e.g., AFAST, Hawaii Rang Complex, Southern California Range Complex), as well as Navy funded research and development studies (Figure 5-4). The ICMP will coordinate the monitoring programs progress towards meeting its goals and develop a data management plan. A program review board is also being considered to provide additional guidance. The ICMP will be evaluated annually to provide a matrix for progress and goals for the following year, and will make recommendations on adaptive management for refinement and analysis of the monitoring methods.

The primary objectives of the ICMP are to:

- Monitor and assess the effects of Navy activities on protected species;
- Ensure that data collected at multiple locations is collected in a manner that allows comparison between and among different geographic locations;
- Assess the efficacy and practicality of the monitoring and mitigation techniques;
- Add to the overall knowledgebase of marine species and the effects of Navy activities on marine species.

The ICMP will be used both as: (1) a planning tool to focus Navy monitoring priorities (pursuant to ESA/MMPA requirements) across Navy Range Complexes and Exercises; and (2) an adaptive management tool, through the consolidation and analysis of the Navy's monitoring and watchstander data, as well as new information from other Navy programs (e.g., research and development), and newly published non-Navy information.

The ICMP will establish a method (likely an annual review meeting) for NMFS and the Navy to jointly consider prior years monitoring results and advancing science to determine if modifications are needed in mitigation or monitoring measures to better effect the goals laid out in the Mitigation and Monitoring section. The annual review provides potential mechanism for restructuring the monitoring plans and allocating monitoring effort based on the strength of particular specific monitoring proposals that have been developed through the ICMP framework, instead of allocating based on maintaining an equal (or commensurate to effects) distribution of monitoring effort across Range complexes. For example, if careful prioritization and planning through the ICMP shows that a large, intense monitoring effort in a particular location would provide extensive and robust much-needed data that is applicable to assessing the effects of sonar throughout different geographical areas, it may be appropriate to have other Range Complexes (through the respective LOAs) focus resources on that specific monitoring proposal in lieu of focusing on smaller, lower priority projects divided throughout the individual.

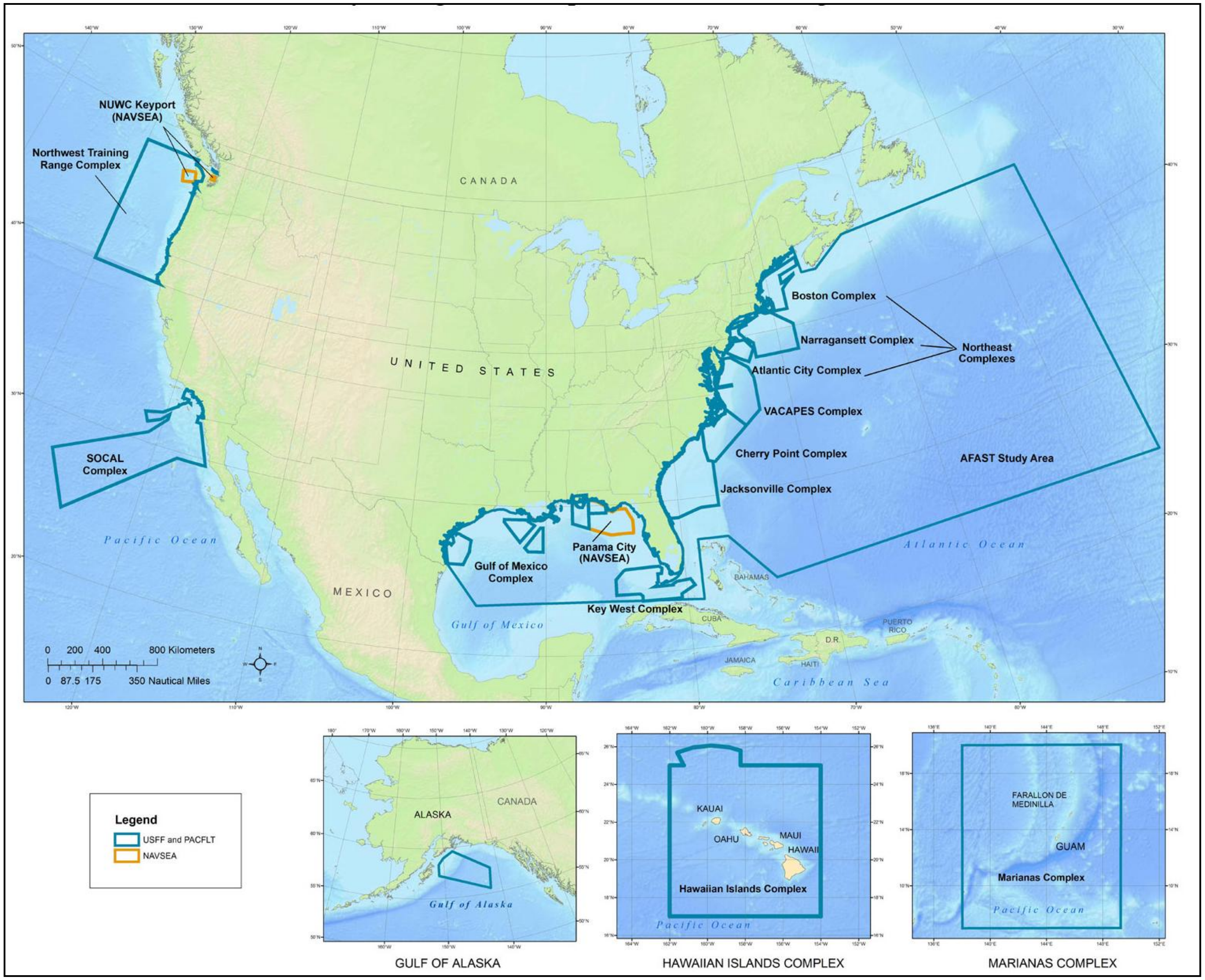


Figure 5-4. Navy-Wide Area Map of Areas Where Data Collection is Expected to Occur

This page is intentionally blank.

Adaptive management principles consider appropriate adjustments to mitigation, monitoring, and reporting as the outcomes of the proposed actions and required mitigation are better understood. NMFS includes adaptive management principles in the regulations for the implementation of the proposed action, and any adaptive adjustments of mitigation and monitoring would be led by NMFS via the MMPA process and developed in coordination with the Navy. Continued opportunity for public input would be included via the MMPA process, as appropriate (i.e. via the "Letter of Authorization" process). The intent of adaptive management here is to ensure the continued proper implementation of the required mitigation measures, to conduct appropriate monitoring and evaluation efforts, and to recommend possible adjustments to the mitigation/monitoring/reporting to accomplish the established goals of the mitigation and monitoring.

5.5.2 Research

The Navy provides a significant amount of funding and support to marine research through a variety of organizations. From FY04 to FY08, the Navy provided over $94 million to universities, research institutions, federal laboratories, private companies, and independent researchers around the world for marine life research. During this same time period, the DoD contributed nearly $6 million for a total of $100 million in marine life research projects. These projects include basic science efforts, such as baseline surveys, and do not include monitoring surveys or environmental planning document preparation (DON, 2008c). In FY08 alone, the Navy will spend over $26 million and the DoD almost $1 million towards this effort (DON, 2008c). Currently, the Navy has budgeted nearly $22 million and the DoD has budgeted a half a million dollars for continued marine mammal research in FY09 (DON, 2008c). Major topics of Navy-supported research include the following:

- Better understanding of marine species distribution and important habitat areas,
- Developing methods to detect and monitor marine species before and during training,
- Understanding the effects of sound on marine mammals, sea turtles, fish, and birds, and
- Developing tools to model and estimate potential effects of sound.

This research is directly applicable to Atlantic Fleet training activities, particularly with respect to the investigations of the potential effects of underwater noise sources on marine mammals and other protected species. Proposed training activities employ sonar and underwater explosives, which introduce sound into the marine environment.

The Marine Life Sciences Division of the Office of Naval Research currently coordinates six programs that examine the marine environment and are devoted solely to studying the effects of noise and/or the implementation of technology tools that will assist the Navy in studying and tracking marine mammals. The six programs are as follows:

1. Environmental Consequences of Underwater Sound,
2. Non-Auditory Biological Effects of Sound on Marine Mammals,
3. Effects of Sound on the Marine Environment,
4. Sensors and Models for Marine Environmental Monitoring,

5. Effects of Sound on Hearing of Marine Animals, and
6. Passive Acoustic Detection, Classification, and Tracking of Marine Mammals.

The Navy has also developed the technical reports referenced within this document, which include the Marine Resource Assessments and the Navy OPAREA Density Estimates (NODE) reports. Furthermore, research cruises by NMFS and by academic institutions have received funding from the U.S. Navy. For instance, the ONR contributed financially to the Sperm Whale Seismic Survey (SWSS) in the Gulf of Mexico, coordinated by Texas A&M. The goals of the SWSS are to examine effects of the oil and gas industry on sperm whales and what mitigations would be employed to minimize adverse effects to the species. All of this research helps in understanding the marine environment and the effects that may arise from the use of underwater noise in the Gulf of Mexico and western North Atlantic Ocean.

The Navy has sponsored several workshops to evaluate the current state of knowledge and potential for future acoustic monitoring of marine mammals. The workshops brought together acoustic experts and marine biologists from the Navy and other research organizations to present data and information on current acoustic monitoring research efforts and to evaluate the potentialfor incorporating similar technology and methods on instrumented ranges. However, acoustic detection, identification, localization, and tracking of individual animals still requires a significant amount of research effort to be considered a reliable method for marine mammal monitoring. The Navy supports research efforts on acoustic monitoring and will continue to investigate the feasibility of passive acoustics as a potential mitigation and monitoring tool.

A workshop was held in May 2007 at Duke University to discuss the research required to understand the impact of tactical mid-frequency sonar transmission on fish, fisheries and fisheries habitat. Workshop participants included personnel from the Navy, academic universities, and NOAA Fisheries Service, who were selected based on their expertise in acoustics, fish hearing and fisheries biology. The objective of the workshop was to describe the range of scientific concerns regarding the effects of Navy training activities using tactical mid-frequency active sonar on fish and fisheries resources and to distill these concerns into a long-term research and development plan. The priorities of the workshop included larval fish effects, hearing capabilities, small pelagic and soniferous fish behavior and potential effects to fisheries.

Overall, the Navy will continue to fund ongoing research, and is planning to coordinate long term monitoring/studies of marine mammals on various established ranges and operating areas. The Navy will continue to research and contribute to university/external research to improve the state of the science regarding marine species biology and acoustic effects.

5.6 ALTERNATIVE MITIGATION MEASURES CONSIDERED BUT ELIMINATED

As described in Chapter 4, the vast majority of estimated sound exposures of marine mammals during proposed active sonar activities would not cause injury. Potential acoustic effects on marine mammals would be further reduced by the mitigation measures described above. Therefore, the Navy concludes the Proposed Action and mitigation measures would achieve the least practicable adverse impact on species or stocks of marine mammals.

A determination of "least practicable adverse impacts" includes consideration of personnel safety, practicality of implementation, and impact on the effectiveness of the military readiness activity in consultation with the Department of Defense (DoD). A number of possible alternative and/or additional mitigation measures have been reviewed in the past in the development of the current measures or have been suggested during the public comment period. This section presents measures and an evaluation based on known science, likely effectiveness, impact to military readiness activities personnel safety, and the practicality of implementation. Alternative measures in addition to those currently in use include the following:

- Scaling down training.
- Using ramp-up to attempt to clear an exercise area prior to the use of sonar.
- Using non-Navy personnel onboard Navy vessels to provide surveillance of ASW or other training events to augment Navy lookouts.
- Using non-Navy observers for visual surveillance.
- Surveying before, during, and after training events.
- Suspending training at night, periods of low visibility, and in high sea-states when marine mammals are not readily visible.
- Reducing power in strong surface duct conditions.
- Reducing vessel speed.
- Using larger shut-down zones.
- Limiting the active sonar event locations (avoid areas seasonally, areas with problematic complex/steep bathymetry and/or seamounts, or particular habitats).
- Avoiding active sonar use within (1) 22.2 km (12 NM) from shore; (2) 25 km (13.5 NM) from the 200-m (656-ft) isobath; or (3) 46.3 km (25 NM) from shore.
- Using active sonar with output levels as low as possible consistent with mission requirements.
- Using active sonar only when necessary.
- Adopting mitigation measures of foreign nation navies.
- Reporting marine mammal sightings to augment scientific data collection.

5.6.1 Evaluation of Alternative and/or Additional Mitigation Measures

There is a distinction between effective and feasible monitoring procedures for data collection and measures employed to prevent impacts or otherwise serve as mitigation. The discussion below is in reference to those procedures meant to serve as mitigation measures.

- Reduction of training. The requirements for training have been developed through many years of iteration to ensure Sailors achieve the levels of readiness needed to ensure they are prepared to properly respond to the many contingencies that may occur during an actual mission. These training requirements are designed to provide the experience needed to ensure Sailors are properly prepared for operational success. There is no extra training built in to the plan, as this would not be an efficient use of the resources needed to support the training (e.g. fuel, time). Therefore, any reduction of training would not allow Sailors to achieve satisfactory levels of readiness needed to accomplish their mission.

- Using ramp-up to attempt to clear the range prior to the conduct of exercises. Ramp-up procedures, (slowly increasing the sound in the water to necessary levels), are not a viable alternative for training exercises because the ramp-up would alert opponents to the participants' presence. This affects the realism of training in that the target submarine would be able to detect the searching unit prior to themselves being detected, enabling them to take evasive measures. This would insert a significant anomaly to the training, affecting its realism and effectiveness. Though ramp-up procedures have been used in testing, the procedure is not effective in training Sailors to react to tactical situations, as it provides an unrealistic advantage by alerting the target. Using these procedures would not allow the Navy to conduct realistic training, or "train as they fight," thus adversely impacting the effectiveness of the military readiness activity.
- Conducting visual monitoring using third-party observers from air or surface platforms, in addition to the existing Navy-trained lookouts.
  - The use of third-party observers would compromise security due to the requirement to provide advance notification of specific times/locations of Navy platforms.
  - Reliance on the availability of third-party personnel would also impact training flexibility, thus adversely affecting training effectiveness. The presence of other aircraft in the vicinity of naval exercises would raise safety concerns for both the commercial observers and naval aircraft.
  - Use of Navy observers is the most effective means to ensure quick and effective implementation of mitigation measures if marine species are spotted. A critical skill set of effective Navy training is communication. Navy lookouts are trained to act swiftly and decisively to ensure that appropriate actions are taken.
  - Use of third-party observers is not necessary because Navy personnel are extensively trained in spotting items on or near the water surface. Navy spotters receive more hours of training, and use their spotting skills more frequently, than many third-party trained personnel.
  - Crew members participating in training activities involving aerial assets have been specifically trained to detect objects in the water. The crew's ability to sight from both surface and aerial platforms provides excellent survey capabilities using the Navy's existing exercise assets.
  - Security clearance issues would have to be overcome to allow non-Navy observers onboard exercise participants.
  - Some training events will span one or more 24-hour periods, with operations underway continuously in that timeframe. It is not feasible to maintain non-Navy surveillance of these operations, given the number of non-Navy observers that would be required onboard.
  - Surface ships having active mid-frequency sonar have limited berthing capacity. As exercise planning includes careful consideration of this limited capacity in the placement of exercise controllers, data collection personnel, and Afloat Training

Group personnel on ships involved in the exercise. Inclusion of non-Navy observers onboard these ships would require that in some cases there would be no additional berthing space for essential Navy personnel required to fully evaluate and efficiently use the training opportunity to accomplish the exercise objectives.

- ◦ The areas where training events will most likely occur in the AFAST Study Area (overall greater than 2.1 million square nautical miles [NM^2]) cover approximately 3.4 million square kilometers (km^2) (1,000,000 square nautical miles [NM^2]). Contiguous ASW events may cover many hundreds or even thousands of square miles. The number of civilian ships and/or aircraft required to monitor the area of these events would be considerable. It is, thus, not feasible to survey or monitor the large exercise areas in the time required to ensure these areas are devoid of marine mammals. In addition, marine mammals may move into or out of an area, if surveyed before an event, or an animal could move into an area after an exercise took place. Given that there are no adequate controls to account for these or other possibilities, there is little utility to performing extensive before or after event surveys of large exercise areas as a mitigation measure.
- ◦ Surveying during an event raises safety issues with multiple, slow civilian aircraft operating in the same airspace as military aircraft engaged in combat training activities. In addition, most of the training events take place far from land, limiting both the time available for civilian aircraft to be in the exercise area and presenting a concern should aircraft mechanical problems arise.
- ◦ Scheduling civilian vessels or aircraft to coincide with training events would impact training effectiveness, since exercise event timetables cannot be precisely fixed and are instead based on the free-flow development of tactical situations. Waiting for civilian aircraft or vessels to complete surveys, refuel, or be on station would slow the progress of the exercise and impact the effectiveness of the military readiness activity.
- ◦ Multiple events may occur simultaneously in areas at opposite ends of the AFAST Study Area and continue for up to 96 hours. There are not enough qualified third-party personnel to accomplish the monitoring task.

- Reducing or securing power during the following conditions.
  - ° Low-visibility/night training: The Navy must train in the same manner as it will fight. ASW can require a significant amount of time to develop the "tactical picture," or an understanding of the battle space such as area searched or unsearched, identifying false contacts, understanding the water conditions, etc. Reducing or securing power in low-visibility conditions would affect a commander's ability to develop this tactical picture as well as not provide the needed training realism. By training differently than what would be needed in an actual combat scenario would decrease training effectiveness and reduce the crew's abilities. Therefore, the Navy cannot operate only in daylight hours or wait for the weather to clear before training.

- ◦ Strong surface duct: The Navy must train in the same manner as it will fight. As described above, the complexity of ASW requires the most realistic training possible for the effectiveness and safety of the Sailors. Reducing power in strong surface duct conditions would not provide this training realism because the unit would be operating differently than it would in a combat scenario, reducing training effectiveness and the crew's ability. Additionally, water conditions in the various proposed OPAREAs may change rapidly, resulting in continually changing mitigation requirements, resulting in a focus on mitigation versus training.

- Vessel speed: Establish and implement a set vessel speed.
  - ◦ As discussed in Section 5.3, Navy personnel are already required to use extreme caution and operate at a slow, safe speed consistent with mission and safety. Ships and submarines need to be able to react to changing tactical situations in training as they would in actual combat. Placing arbitrary speed restrictions would not allow them to properly react to these situations. By training differently than what would be needed in an actual combat scenario would decrease training effectiveness and reduce the crew's abilities.

- Extending safety zone requirements.
  - ◦ The current safety zones requirement to power down of mid-frequency active sonar at 457 and 914 m (500 and 1,000 yd), as well as shut down at 183 m (200 yd) were developed to minimize exposing marine mammals to sound levels that could cause temporary threshold shift (TTS) or permanent threshold shift (PTS), levels that are supported by the scientific community. Implementation of the safety zones discussed above will prevent exposure to sound levels greater than 195 dB re 1µPa for animals sighted. The safety range the Navy has developed is also within a range Sailors can realistically maintain situational awareness and achieve visually during most conditions at sea. Requirements to implement procedures when marine mammals are present well beyond 914 m (1,000 yd) require that lookouts sight marine mammals at distances that, in reality, they cannot. These increased distances also greatly increase the area that must be monitored to implement these procedures. For instance, if a power down zone increases from 914 to 3,658 m (1,000 to 4,000 yd), the area that must be monitored increases sixteen fold.
  - ◦ Although the three action alternatives were developed using marine mammal density data and areas believed to provide habitat features conducive to marine mammals, not all such areas could be avoided. ASW requires large areas of ocean space to provide realistic and meaningful training to the Sailors. These areas were considered to the maximum extent practicable while ensuring the Navy's ability to properly train its forces in accordance with federal law. Avoiding any area that has the potential for marine mammal populations is impractical and would impact the effectiveness of the military readiness activity.

- Limiting the active sonar use to a few specific locations.
  - ◦ Areas where events are scheduled to occur are carefully chosen to provide for the safety of events and to allow for the realistic tactical development of the training scenario. Otherwise limiting the training event to a few areas would adversely impact the effectiveness of the training.

  - ◦ Major Exercises using integrated warfare components require large areas of the littorals and open ocean for realistic and safe training.

- Avoiding active sonar use within (1) 22.2 km (12 NM) from shore; (2) 25 km (13 NM) from the 200-m (656-ft) isobath; or (3) 46 km (25 NM) from shore.
  - ◦ The measure requiring avoidance of mid-frequency active sonar within 25 km (13 NM) of the 200-m (656-ft) isobaths was part of the RIMPAC 2006 authorization by NMFS. This measure lacks any scientific basis when applied to the context in AFAST (i.e. the bathymetry, sound propagation, width of channels).
  - ◦ There is no scientific analysis indicating this measure is protective and no known basis for these specific metrics.
  - ◦ The RIMPAC 2006 mitigation measure precluded active ASW training in the littoral region, which significantly impacted realism and training effectiveness (such as for amphibious landings).
  - ◦ This procedure had no observable effect on the protection of marine mammals during RIMPAC 2006 and its value is unclear. However, its effect on realistic training, as with all arbitrary distance from land restrictions, is significant.
- Using active sonar with output levels as low as possible consistent with mission requirements and use of active sonar only when necessary.
  - ◦ Operators of sonar equipment are always cognizant of the environmental variables affecting sound propagation. In this regard, the sonar equipment power levels are always set consistent with mission requirements.
  - ◦ Active sonar is only used when required by the mission since it has the potential to alert opposing forces to the sonar platform's presence. Passive sonar and all other sensors are used in concert with active sonar to the maximum extent practicable when available and when required by the mission.
- Adopt mitigation measures of foreign nation navies
  - ◦ Other nation's navies do not have the same critical requirement to train in ASW as does the Navy. For example, most other navies do not possess an integrated Strike Group and do not have an integrated ASW training requirement. Therefore, many of these navies employ mitigation during training as their measures do not impact their training requirements. In addition, the U.S. Navy is relied upon in combined battlegroups to conduct the integrated ASW that protects the entire battlegroup. That is why the Navy's ASW training is built around the integrated warfare concept and is based on the Navy's sensor capabilities, the threats faced, the operating environment, and the overall mission. Implementing other navies' mitigation would be incompatible with our requirements.
- Reporting marine mammal sightings to augment scientific data collection.
  - ◦ Ships, submarines, aircraft, and personnel engaged in training events are intensively employed throughout the duration of the exercise. Their primary duty is accomplishment of the exercise goals, and they should not be burdened with additional duties unrelated to that task. Any additional workload assigned that is

unrelated to their primary duty would adversely impact the effectiveness of the military readiness activity they are undertaking.

6. CUMULATIVE IMPACTS

6.1 CUMULATIVE IMPACTS

The Navy's past experience in preparing cumulative impacts analyses and the National Environmental Policy Act of 1969 (NEPA) were utilized in determining the scope and format of the cumulative impacts analysis presented within this chapter of the Atlantic Fleet Active Sonar Training (AFAST) Environmental Impact Statement/Overseas Environmental Impact Statement (EIS/OEIS).

The approach taken in the analysis of cumulative effects follows the objectives of NEPA of 1969, Council on Environmental Quality (CEQ) regulations and CEQ guidance. CEQ regulations (40 Code of Federal Regulations [CFR] §§ 1500-1508) provide the implementing procedures for NEPA. The regulations define cumulative effects as:

> "Cumulative impact" is the impact on the environment that results from the incremental impact of the action when added to the other past, present, and reasonably foreseeable future actions regardless of what agency (Federal or non-Federal) or person undertakes such other actions. Cumulative impacts can result from individually minor but collectively significant actions taking place over a period of time (40 CFR 1508.7)."
>
> "To determine the scope of environmental impact statements, agencies shall consider ….[c]umulative actions, which when viewed with other proposed actions have cumulatively significant impacts and should therefore be discussed in the same impact statement."

In addition, the CEQ has published guidance addressing implementation of cumulative impact analyses under NEPA. The CEQ guidance publication entitled *Considering Cumulative Impacts Under the National Environmental Policy Act, January 1997* states that the analyses should:

> "…determine the magnitude and significance of the environmental consequences of the proposed action in the context of the cumulative impacts of other past, present, and future actions... identify significant cumulative impacts…[and]…focus on truly meaningful impacts."

Based on the guidance provided within this CEQ publication, the Navy has determined the following types of potential cumulative impacts need to be analyzed:

- "additive" (the total loss of a resource from more than one incident),
- "countervailing" (adverse impacts that are compensated for by beneficial effects), and
- "synergistic" (when the total effect is greater than the sum of the effects taken independently).

However, the analysis of cumulative effects may go beyond the scope of project-specific direct and indirect effects to include expanded geographic and time boundaries and a focus on broad resource sustainability. The true geographic range of an action's effect may not be limited to an arbitrary political or administrative boundary. Similarly, the effects of an action may continue beyond the time the action ceases. This "big picture" approach is becoming increasingly important as growing evidence suggests that the most significant effects result not from the direct effects of a particular action, but from the combination of individual, often minor, effects of multiple actions over time. The underlying issue is whether or not a resource can adequately recover from the effect of an action before the environment is exposed to a subsequent action or actions.

The AFAST active sonar activities are expected to occur in and adjacent to existing Operating Areas (OPAREAs) located along the East Coast of the United States (U.S.) and in the Gulf of Mexico, collectively referred to as the Study Area. Military training, maintenance, and research, development, test, and evaluation (RDT&E) activities have previously occurred in these areas. Further, the mid- and high-frequency active sonar and improved extended echo ranging (IEER) system training, maintenance, and RDT&E activities are short-term, temporary, and do not involve land acquisition, new construction, or expansion of military presence. The activities involving mid- and high-frequency active sonar described in this EIS/OEIS are not new and do not involve significant changes in systems, tempo, or intensity from past activities, or any additional geographic locations.

For the purposes of determining cumulative effects in this chapter, the Navy reviewed all environmental documentation regarding known current and past federal and non-federal actions (Section 6.2) associated with the resources analyzed in Chapter 4. Additionally, projects in the planning phase were considered, including reasonably foreseeable (rather than speculative) actions that have the potential to interact with the proposed Navy action (see Section 6.3). Specific emphasis is placed on projects in and adjacent to each of the OPAREAs located along the East Coast and in the Gulf of Mexico that involve components capable of generating in-water sounds given the proportion of effects analysis devoted to this issue. The level of information available for the different projects varies. The best available science is used in this analysis. The cumulative analysis incorporates specific numbers and values for potential effects, where available; descriptive information is used in place of quantitative measures where they are unavailable. Additionally, the National Marine Fisheries Service (NMFS) reviews the status of listed species and the environmental baseline of these species, as well as considering cumulative effects, in their issuance of the Biological Opinion that will result from the navy's consultation under Section 7 of the ESA.

6.1.1 Assumptions Used in the Analysis

The cumulative impacts analysis in this chapter differs from the analysis conducted for the AFAST Alternatives detailed in Chapter 4 because the cumulative impacts analysis considers an expanded geographic area and extended timeframe. Therefore, the cumulative impacts analysis includes additional effects on the physical, biological, and human environments associated with AFAST active sonar activities.

In accordance with the NEPA, the cumulative impacts analysis must take into consideration the incremental contribution of the proposed action to the existing baseline. However, as activities increase within the Study Area, the baseline will change. Thus, the baseline for the cumulative impacts analysis must include past, present, and reasonably foreseeable future activities. In addition, the cumulative impacts analysis takes into consideration combined effects of past, present, and reasonably foreseeable future activities. Therefore, the baseline utilized in the Alternatives analysis presented in Chapter 3 of this EIS/OEIS could not be used in the cumulative impacts analysis. The baseline associated with the cumulative impact analysis had to take into account the effects of both past and present activities.

The incremental contribution of the proposed action is relatively small and would most likely continue to reduce in size as non-military activities increase within the Study Area. Overall, it is more difficult to analyze cumulative impacts versus project-specific effects. The Navy recognizes the need to identify and quantify the factors causing the environmental change and the threshold triggers associated with the potential environmental response.

6.1.2 Summary and Significance of Past Cetacean Stranding Events Related to Military Use of Sonar

With the exception of historic whaling in the 19th and early part of the 20th century, during the past few decades there has been an increase in marine mammal mortalities associated with a variety of human activities (Geraci et al., 1999; NMFS, 2007j). These include fisheries interactions (bycatch and directed catch), pollution (marine debris, toxic compounds), habitat modification (degradation, prey reduction), vessel strikes (Laist et al., 2001), and gunshots. In addition, during the past 10 years, naval sonar has been putatively linked to only 5 stranding events worldwide, with a total of 51 stranded animals and 37 mortalities. The 37 mortalities equate to an average of fewer than 4 marine mammal mortalities per year over the past 10 years.

These five strandings are unique from other strandings because in these cases, unique conditions may have existed in the active sonar activity area that, in their aggregate, may have contributed to the marine mammal strandings. For example, the stranding of whales occurred over a short period of time, stranded individuals were spatially co-located, traumas in stranded animals were consistent between events, and active sonar was known or suspected to be in use. Moreover, in several of these strandings, activities involved multiple ships operating in the same area over extended periods of time in close proximity. Furthermore, operations occurred across a relatively short horizontal distance, in areas surrounded by landmasses, and of at least 1,000 meters (m) (3,281 feet [ft]) in depth near a shoreline with a rapid change in bathymetry. However, these conditions are not present in the majority of other documented marine mammal strandings, and current science suggests that multiple factors, both natural and man-made, may each be acting alone or in combination to cause marine mammals to strand.

Overall, the number of deaths during stranding events associated with mid-frequency active sonar exposure is small in comparison to the number of marine mammals killed annually through fishing by-catch and whaling operations. For example, the mean annual bycatch from 1990 through 1999 was 3,029 marine mammals (Read et al., 2006). Bycatch data from 1990 through 1994 was extrapolated by Read et al., (2006) to consider global impacts; when this was done, approximately 308,000 marine mammal deaths have resulted annually. Waring et al., (2008) provided a mean annual mortality of 702 to Western North Atlantic cetaceans (excluding pinnipeds) by observed fisheries in 2001 through 2005. In addition to by-catch, some countries still engage in whaling operations for research and commercial purposes. Such operations led to the death of almost 1,500 marine mammals in 2006 (International Whaling Commission [IWC], 2008). Thus, the overall contribution of cetaceans' stranding resulting in death associated with exposure to naval mid-frequency sonar is relatively small when compared to all the other non-military activity related to marine mammal stranding and effects, as shown in Figure 6-1. Refer to Appendix E, Cetacean Stranding Report, for additional information.

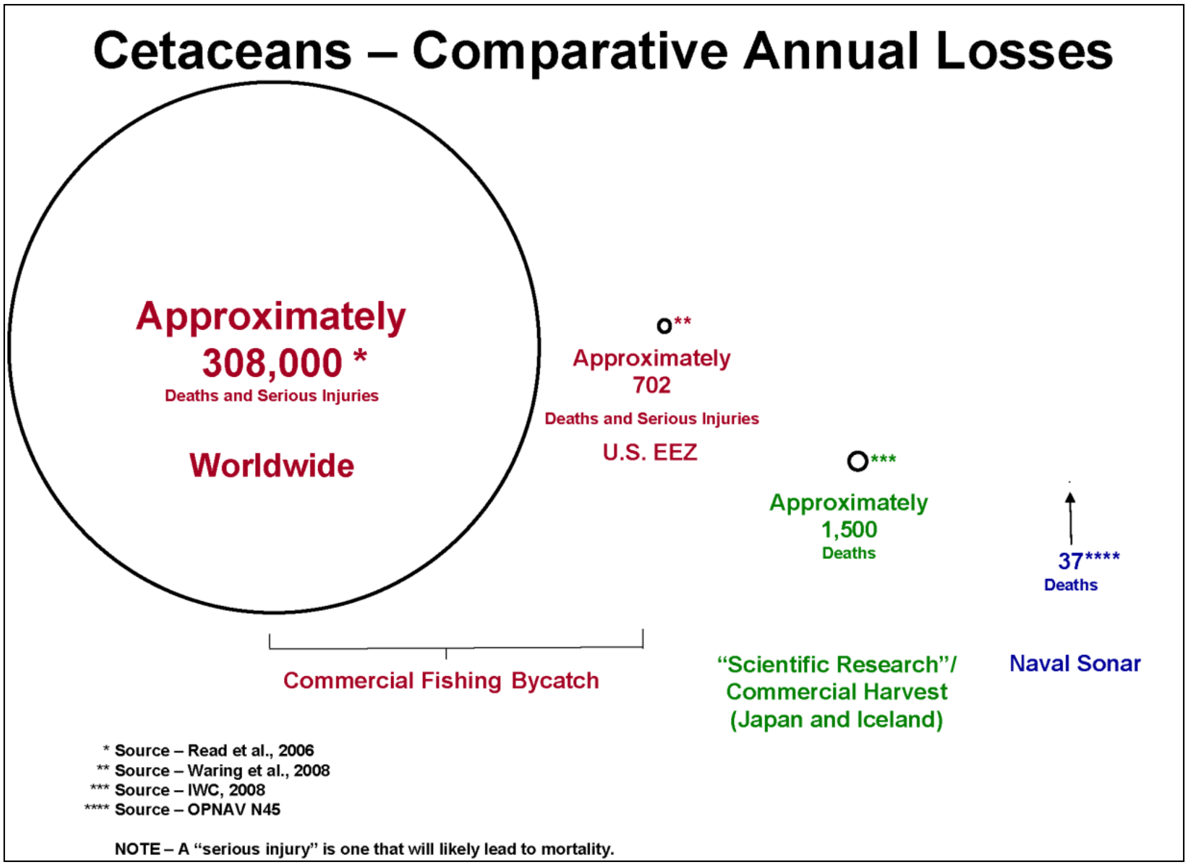


Figure 6-1. Annual Comparison of Cetacean Death by Activity

The Navy has made the protection of marine mammals a top priority. The Navy has led the way in marine mammal research, and in conjunction with the National Oceanic and Atmospheric Administration (NOAA), has developed 29 mandatory science-based mitigation measures that allow the Navy to conduct active sonar activities with the utmost care for the ocean environment. Refer to Chapter 5, Mitigation Measures, for additional information.

6.2 PAST AND PRESENT ACTIONS

Various types of past and present actions not related to the Proposed Action have the potential to affect the resources identified in Chapter 3. The overview of these actions in this section emphasizes components of the activities that are relevant to the effects analysis in Chapter 4. Geographic distribution, intensity, duration, and the historical effects of similar activities are considered when determining whether a particular activity may contribute cumulatively and significantly to the impacts on resource areas identified in Chapter 4. The past and present actions discussed in this section are based upon the best available data available to the public as of September 30, 2008.

6.2.1 Commercial and Recreational Fishing

The fishing industry affects resources, including marine mammals and sea turtles. The mean annual mortality of Western North Atlantic marine mammals as a result of by-catch is estimated at 2,615 (i.e., 702 cetaceans and 1,913 pinnipeds) (Waring et al., 2008). Adverse effects to protected marine species are possible due to gillnet, longline, trawlgear, and pot fisheries. Additionally, commercial fisheries may incidentally entangle and drown or injure cetaceans by lost and expended fishing gear (e.g., Northridge and Hofman, 1999). For example, entanglement in fixed fishing gear, in particular in sink gillnets and a variety of pot and trap fisheries, is one of the most important factors depressing the growth rate of the North Atlantic right whale population (Kenney, 2002). Additionally, fisheries may indirectly compete with cetaceans by reducing the amount of primary food source accessible to cetaceans, thereby negatively affecting their numbers (Trites et al., 1997). Southeastern shrimp trawl and summer flounder/scup/black sea bass fisheries are considered to be most likely to adversely affect sea turtles; however, shrimp trawling has the greatest effect. However, the use of "turtle-excluder devices" (TEDs) in the shrimp fishery was estimated to reduce sea turtle bycatch by approximately 97 percent (NOAA, 2004). As an example of the success of TEDs, in South Carolina waters, mortality was reduced by approximately 44 percent in the law's first four years (Gibbons, 2008).

Fisheries are classified first, according to the total effect of all fisheries on each marine mammal stock and second, by addressing the effect of individual fisheries on each stock. This classification method includes consideration of the rate, in numbers of animals per year, of incidental mortalities and serious injuries of marine mammals due to commercial fishing operations relative to the potential biological removal (PBR) level for each stock. The PBR level is the maximum number of animals, not including natural mortalities, which may be removed from a marine mammal stock while allowing that stock to reach or maintain its optimum sustainable population (NMFS, 2007k). Category I fisheries are the most detrimental to marine mammals and are defined as having an annual mortality and serious injury of a stock in a given fishery of greater than or equal to 50 percent of the PBR level (NMFS, 2007k). Table 6-1 shows the Category I commercial fisheries in the Atlantic Ocean and Gulf of Mexico and the marine mammal species affected.

Along the Atlantic and Gulf Coast, almost 2.8 billion pounds of fish were commercially caught with a value of over $2.1 billion (NMFS, 2007g). In addition, over 12 million Americans participate in saltwater recreational fishing along the Atlantic and Gulf Coast (NMFS, 2007g). In the past ten years, the number of participants has increased 54 percent and the number of recreational fishing trips has increased to 82 million trips (NMFS, 2007g). Nationwide, recreational saltwater recreational fishing generated over $30 billion in sales in 2000 and supported about 350,000 jobs (Steinbeck et al., 2004).

Table 6-1. Category I Commercial Fisheries in the Atlantic Ocean and Gulf of Mexico

Fishery Description	Estimated Number of Vessels/Persons	Marine Mammal Species Incidentally Killed/Injured		
Gillnet Fisheries	>1,011	Fin whale Humpback whale Long-finned pilot whale Minke whale Atlantic Ocean right whale Short-finned pilot whale	Bottlenose dolphin Common dolphin Harbor porpoise Risso's dolphin White-sided dolphin	Gray seal Harbor seal Harp seal Hooded seal
Longline Fisheries	94*	Cuvier's beaked whale Long-finned pilot whale Mesoplodon beaked whale Northern bottlenose whale Pygmy sperm whale Short-finned pilot whale	Atlantic spotted dolphin Bottlenose dolphin Common dolphin Pantropical spotted dolphin Risso's dolphin	----
Trap/Pot Fisheries	13,000	Fin whale Humpback whale Minke whale Atlantic Ocean right whale	----	Harbor seal

NMFS, 2007k
*Some Caribbean fisheries are included in this number

6.2.1.1 Commercial and Recreational Fisheries –Atlantic Ocean, Offshore of the Southeastern United States

In 2006, commercial fishing off the southeastern U.S. Atlantic coast brought in 540 million pounds of fish with a value of $249 million (NMFS, 2007g). Examples of fish caught include menhaden, flounder, mackerel, crab, sea scallops, and shrimp. Recreational anglers brought in approximately 71 million pounds of fish in 2006 (NMFS, 2007g).

6.2.1.2 Commercial and Recreational Fisheries –Atlantic Ocean, Offshore of the Northeastern United States

In 2006, commercial fishing off the northeastern U.S. Atlantic coast brought in 941 million pounds of fish with a value of $1.2 billion (NMFS, 2007g). Examples of fish caught include Atlantic cod, flounder, goosefish, clams, American lobster, sea scallops, and crabs. Recreational anglers brought in roughly 120 million pounds of fish in 2006 (NMFS, 2007g).

6.2.1.3 Commercial and Recreational Fisheries – Eastern Gulf of Mexico

In 2006, commercial fishing in the eastern Gulf of Mexico brought in 1.2 billion pounds of fish valued at $493 million (NMFS, 2007g). Examples of fish caught include snapper, grouper, mullet, crab, oyster, shrimp, and lobster were the species caught that brought in the most money. In 2006, recreational anglers brought in about 73 million pounds of fish (NMFS, 2007g).

6.2.1.4 Commercial and Recreational Fisheries – Western Gulf of Mexico

In 2006, commercial fishing in the western Gulf of Mexico (i.e., Texas) brought in 117 million pounds of fish valued at $197 million (NMFS, 2007g). Examples of fish caught include snapper, menhaden, tuna, crab, oyster, and shrimp (NMFS, 2007d). Between 2000 and 2001, recreational anglers in Texas caught 2.5 million fish in the Gulf of Mexico.

6.2.2 Onshore and Offshore Liquefied Natural Gas (LNG) Facilities

Liquefied natural gas (LNG) is natural gas that has been cooled about -260 degrees Fahrenheit (°F) until the gas is in its liquid form. When natural gas is liquefied, it decreases to 1/600 its original volume, which makes it ideal for shipping (Federal Energy Regulatory Commission [FERC], 2005). LNG is transported to LNG terminals by tankers equipped with insulated walls and systems to keep the LNG in liquid form. Once LNG is unloaded from ships at LNG terminals, it is stored as a liquid until it is warmed to convert it back to natural gas. The natural gas is then sent through pipelines for distribution (FERC, 2005).

LNG is odorless, colorless, non-toxic, and will not burn as a liquid. LNG vapors will not explode in a confined environment and are only flammable at concentrations of 5 to 15 percent with air (FERC, 2005). This makes LNG relatively harmless unless vapors are at flammable concentrations around an ignition source.

FERC, the USCG and the Maritime Administration (MARAD) regulate LNG facilities. LNG facilities that lie within state waters are regulated by FERC per the Energy Policy Act of 2005. The USCG and MARAD have jurisdiction over the LNG facilities within federal waters under the Federal Deepwater Ports Act of 1974 (FERC, 2006a).

6.2.2.1 LNG Atlantic Ocean, Offshore of the Southeastern United States

There are currently no existing FERC or MARAD/USCG regulated LNG terminals offshore of the southeastern United States (FERC, 2007).

6.2.2.2 LNG Atlantic Ocean, Offshore of the Northeastern United States

There are currently no existing FERC or MARAD/USCG regulated LNG terminals offshore of the northeastern United States; however, two LNG terminals are located within water bodies adjacent to the Atlantic Ocean (FERC, 2007).

6.2.2.2.1 Existing LNG Facilities, Nearshore Northeastern United States

Everett Marine LNG Terminal - Everett, MA

The Everett Marine Terminal began service in 1971 as the first LNG import facility in the country. The terminal is located on the Mystic River, near Boston, Massachusetts. As a result of the Mystic Rivers' proximity to Boston, tankers must pass through Boston harbor to reach the terminal (Congressional Research Service, 2003). Tractebel LNG North America Limited Liability Company (LLC), a subsidiary of SUEZ LNG NA, owns the facility, that since its inception has received over 600 shipments of LNG from a variety of international sources. The

Everett Marine Terminal currently meets approximately 20 percent of New England's annual gas demand (SUEZ, 2007). Richard L. Grant, President and Chief Executive Officer of Tractebel LNG North America LLC, testified in front of the U.S. Senate Committee on Energy and Natural Resources (CENR) that, “over the last 40 years, there have been approximately 33,000 LNG carrier voyages, covering more than 97 million km (52 million NM) without a single major accident or safety problem either in port or on the high seas” (CENR, 2005).

Dominion Cove Point LNG, LP – Cove Point, MD

The Cove Point terminal began service in 1978 but was forced to close in 1980. In 1995, it was reopened to liquefy, store, and distribute domestic natural gas, and in July 2003 received its first LNG imports. The terminal is owned by Dominion Corporation and is located on the Chesapeake Bay, approximately 97 km (60 mi) southeast of Washington, DC (Congressional Research Service, 2003). The demand for natural gas in the United States is expected to grow by at least 20 percent over the next decade (Dominion, 2007a). As a response to this increased demand, the FERC authorized the expansion of Cove Point LNG’s existing import terminal and pipeline, as well as the construction of new downstream pipeline and storage facilities as part of the Cove Point Expansion Project (FERC, 2006b). According to the Cove Point Expansion Project website, construction of the LNG facilities began in August of 2006. Pipeline facility construction began in 2007 and will continue through 2008. In the fall of 2008, it is expected to be ready for service (Dominion, 2007b).

6.2.2.3 LNG Eastern Gulf of Mexico

There are currently no existing FERC or MARAD/USCG regulated LNG terminals in the eastern Gulf of Mexico.

6.2.2.4 LNG Western Gulf of Mexico

The western Gulf of Mexico is the only region in which a MARAD/USCG-regulated LNG terminal (Gulf Gateway Energy Bridge - Excelerate Energy) has been constructed (FERC, 2007). This offshore LNG receiving facility was established 187 km (101 NM) offshore the coast of Louisiana (Excelerate Energy, 2008).

6.2.3 Exploration, Extraction, and Production of Oil, Gas, and Alternative Energy on the Outer Continental Shelf

The Minerals Management Service (MMS), within the Department of the Interior, manages the mineral resources of the federal offshore lands of the Outer Continental Shelf (OCS). MMS leases OCS lands to commercial companies for the exploration, extraction, and production of mineral resources. The Atlantic OCS area is divided into four planning areas along the Atlantic seaboard: the Atlantic Ocean, Mid-Atlantic, South Atlantic, and the Straits of Florida. The Gulf of Mexico region is divided into the Eastern, Central, and Western Planning Areas (MMS, 2007a).

For the past 26 years leasing of specific portions of the Federal OCS has been prohibited via the annual Congressional appropriations process (e.g. Congress not appropriating funds for MMS to conduct leasing for the specified OCS areas). From 1982 to 1992, Congress supported annual moratoria in specific OCS areas off the coast of California, the North Atlantic, the Mid-Atlantic, the Eastern Gulf of Mexico and all of the North Aleutian Basin (Energy Information Administration, Office of Oil and Gas, 2005).

In 1990, President George H. W. Bush issued a Presidential Directive that enacted a blanket moratorium until 2000 on all unleased areas offshore Northern and Central California, Southern California except for 87 tracts, Washington, Oregon, the North Atlantic coast, and the Eastern Gulf of Mexico coast. Separate from the annual moratoria in appropriations legislation, this directive meant that no leasing or pre-leasing activities were allowed to occur in these areas during the entire period. In 1998, President Clinton extended the moratorium through 2012 (Energy Information Administration, Office of Oil and Gas, 2005).

On August 8, 2005, President George W. Bush signed into law the Energy Policy Act of 2005. This legislation has several provisions that pertain to natural gas and oil development including alternative energy related projects in offshore areas. Of note, the Act requires MMS to conduct a comprehensive inventory and analysis of the estimated natural gas and oil resources on the OCS. The inventory includes moratoria areas which were closed to natural gas and oil leasing. Several provisions in the Act provide increased incentives for natural gas and oil development in offshore areas in order to maintain and stimulate production. Finally, the Energy Policy Act of 2005 granted authority to MMS to manage and oversee alternative-energy related projects on the OCS. Prior to this provision, there was a gap in the law with respect to alternative energy projects (Energy Information Administration, Office of Oil and Gas, 2005).

In April 2007, MMS published the Proposed Final Program (PFP) Outer Continental Shelf Oil and Gas Leasing Program 2007-2012 in conjunction with the Final FEIS 2007-2012 OCS Oil and Gas Leasing Program (MMS, 2007g; 2007h). The FEIS evaluated the possible environmental affects of a proposed leasing program that includes the entire area offshore the coast of Virginia, the Gulf of Mexico, the North Aleutian Basin, and the Chukchi Sea. With regard to the Gulf of Mexico, the MMS FEIS noted that offshore oil and gas activities have the potential to affect military activities, but that U.S. Department of Defense (DOD) and the U.S. Department of Interior (DOI) have cooperated on these issues for many years and have developed mitigation measures that minimize such conflicts. For example, stipulations are applied to oil and gas leases in critical military use areas and are discussed in section 6.2.3.4. Whenever possible, close coordination between oil and gas operators and the military authorities for specific operational areas is encourages, and in some cases, is required under these lease stipulations. In some instances where the military requires unimpeded access to specific areas on the OCS, specific lease blocks have been deleted from one or more proposed lease sales.

As for the Mid-Atlantic/Virginia area, the Navy commented in 2006 on the Proposed Program for OCS Oil and Gas Leasing for 2007- 2012 and the accompanying DEIS that it had concerns about possible operational conflicts with energy activities in this area. However, the Navy supported the 40 km (22 NM) buffer and no obstruction zone and expressed it willingness to discuss possible alternatives to minimize conflicts between energy development and military operations. In the PFP published in April 2007, MMS decided on one special interest sale in

2011, but with a 50-mile buffer and a no obstruction zone from the mouth of the Chesapeake Bay off the coastline of Virginia. Also, MMS noted that the special lease sale in the Mid-Atlantic would only be held if the President chooses to modify the withdrawal and Congress discontinues the annual appropriations moratorium in the Mid-Atlantic.

In October 2007 MMS released a final programmatic EIS supporting the establishment of a program for authorizing alternative energy and alternate use (AEAU) activities on the OCS, as authorized by Section 388 of the Energy Policy Act of 2005 (EPAct), and codified in subsection 8(p) of the Outer Continental Shelf Lands Act (OCSLA) (MMS, 2007m). The final programmatic EIS examines the potential environmental effects of the program on the OCS and identifies policies and best management practices that may be adopted for the program. Under the program, MMS has jurisdiction over AEAU projects on the OCS including, but not limited to: offshore wind energy, wave energy, ocean current energy, offshore solar energy, and hydrogen generation. MMS will also have jurisdiction over other projects that make alternate **use** of existing oil and natural gas platforms in Federal waters on the OCS.

MMS issued the Record of Decision to establish the AEAU program by selecting the Preferred Alternative described in the Final programmatic Environmental Impact Statement. This decision establishes an AEAU program for issuance of leases, easements, and rights-of-way (ROWs) on the OCS for alternative energy activities and the alternate use of structures on the OCS. The Preferred Alternative also provides MMS the option to authorize, on a case-by-case basis, individual AEAU projects that are in the national interest prior to promulgation of the final rule. At the same time, the MMS stated it would vigorously pursue its efforts to complete a comprehensive program with regulations for authorizing and managing AEAU activities on the OCS. Upon promulgation of the final rule, MMS leases, easements, and ROWs for AEAU activities on the OCS would be issued subject to the rule's provisions. On July 9, 2008, MMS issued the proposed regulations for establishing a program to grant leases, easements, and rights-of-ways for alternative energy on the OCS. MMS is working toward issuance of several leases for data gathering and technology testing. These leases will look at varied renewable energy sources in different portions of the OCS (MMS, 2008b).

On July 14, 2008, President Bush removed the executive prohibition on producing oil from the OCS that was in effect until 2012, as mentioned earlier, and requested that Congress take action to lift the restrictions in order to give states the option to recommend the opening of the OCS off their coasts to environmentally responsible exploration (The White House, 2008). In September 2008, the congressional ban on offshore drilling was allowed to expire (Washington Post, 2008).

Many Section 7 consultations have been completed on MMS activities. Until 2002, Biological Opinions (BOs) resulting from Section 7 consultations concluded that one take of sea turtles may occur annually due to vessel strikes. Biological Opinions issued on July 11, 2002 (lease sale 184), November 29, 2002 (multi-lease sales 185, 187, 190, 192, 194, 196, 200, and 201), and August 20, 2003 (lease sales 189 and 197), have concluded that in addition to vessel strikes to sea turtles, adverse effects may occur from seismic surveys and expended materials. Explosive removal of offshore structures may adversely affect sea turtles and marine mammals (U.S. Air Force, 2005b).

In April 2006, MMS applied for a Letter of Authorization (LOA) from NMFS to “take” by harassment a small number of marine mammals, incidental to explosive removal of offshore structures in the Gulf of Mexico (NMFS, 2006h). In this application it was estimated that Level A harassment takes would be five dolphins over the course of five years, and Level B harassment takes would be 457 dolphins and whales combined per year (NMFS, 2006h). However, it was stated that these numbers would be much lower in actuality due to the implementation of mitigation measures (NMFS, 2006h).

In April 2007, a final rule was printed in the Federal Register by MMS requiring the lessees to provide information on how they will conduct their proposed activities in a manner consistent with the Endangered Species Act (ESA) and the Marine Mammal Protection Act (MMPA) (Minerals Management Service (MMS), 2007j). Each lessee would be required to employ monitoring systems and mitigation measures, submit biological environmental reports and environmental effects analyses, and obtain its own authorized incidental “take” permits from NMFS (MMS, 2007j).

6.2.3.1 MMS Regulated Activities – Atlantic Ocean, Offshore of the Southeastern United States

The southeastern Atlantic Coast is divided by MMS into three planning areas: Mid-Atlantic, South Atlantic, and Straits of Florida. These areas combined cover 715,970 km^2 (208,477 NM^2) from Delaware to the southern most tip of Florida. From 1959 until 2000, 307 blocks (8,531 km^2 or 2,484 NM^2) were leased (MMS, 2007b). There are currently no active leases and no activity in this area (MMS, 2007h). However, a special interest sale in the Mid-Atlantic region off the coast of Virginia has been proposed in late 2011 (MMS, 2007h).

6.2.3.2 MMS Regulated Activities – Atlantic Ocean, Offshore of the Northeastern United States

The Atlantic Ocean Planning Area is composed of an area offshore that covers 373,930 km^2 (108,881 NM^2) from Maine to New Jersey (MMS, 2007a). In 1979, 63 blocks (1,452 km^2 or 423 NM^2) were leased (MMS, 2007b). However, there are currently no active leases and no activity in this area (MMS, 2007h).

6.2.3.3 MMS Regulated Activities – Eastern Gulf of Mexico

An Environmental Impact Statement (EIS) was prepared to address two lease sales in the Eastern Gulf of Mexico Planning Area, Lease Sale 189 and 197 (MMS, 2003b). Resources analyzed applicable to this EIS/OEIS include water quality, marine mammals, sea turtles, coastal and marine birds, fish resources, essential fish habitat, commercial fishing, and recreational fishing. With the exception of an accidental event, no significant impacts were expected to these resources (MMS, 2003b). Lease Sale 189 was held in 2003 and Lease Sale 197 was held in 2005. This lease sale area abuts the westernmost border of the Eastern Planning Area, and is comprised of 256 blocks covering more than 6,000 km^2 (1,747 NM^2) in water depths of 1,600 to 3,000 m (5,200 to 9,800 ft). The northeast corner of the proposed lease sale area is located in W-155A (approximately 150 km [81 NM] from the Alabama coast and 161 km [87 NM] from the Florida coast). The great majority (94 percent) of the area is located in Eglin Water Training Areas

(EWTAs) 1 and 3. A small number of lease blocks have been drilled and/or are in gas production.

In addition, the Gulf of Mexico Energy Security Act of 2006, signed by President Bush on 20 December 2006, mandated portions of the Eastern Planning Area (Figure 6-2) be offered for oil and gas leasing (MMS, 2006b). Specifically, The Gulf of Mexico Energy Security Act of 2006 allows for oil and gas leasing in the "181 Area," comprising an area of approximately 2,347 km^2 (683 NM^2) in the Eastern Planning Area (this area is situated 201 km [108 NM] from the Florida panhandle) (MMS, 2006d).

MMS Central Planning Area extends into the western portion of W-155 (Pensacola OPAREA) (MMS, 2003b). A number of active lease blocks are present in the area, with a few additional blocks receiving lease bids in 2003. Additionally, The Gulf of Mexico Energy Security Act of 2006 will allow for oil and gas leasing in the "181 Area," comprising 8,093 km^2 (2,357 NM^2) in the Central Planning Area. A second area of approximately 23,471 km^2 (6,835 NM^2) is located in the Central Gulf of Mexico Planning Area south of the "181 Area" and is referred to as the "181 South Area." None of the area made available by the Gulf of Mexico Energy Security Act is located east of the Military Mission Line.

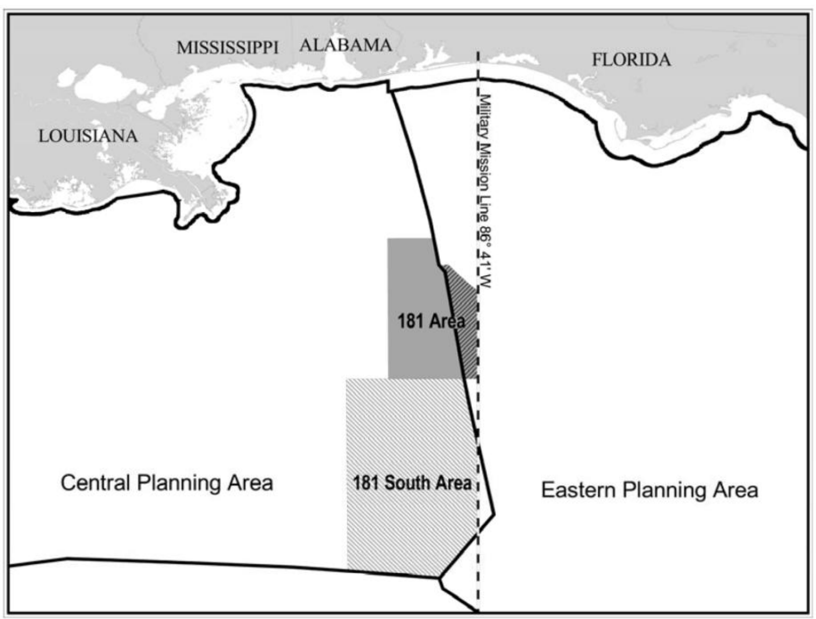


Figure 6-2. Eastern Gulf of Mexico Planning Area
Source: MMS, 2007i

In April 2007, a Final Environmental Impact Statement (EIS) was prepared for Lease Sales 205, 206, 208, 213, 216, and 222; and Western Planning Area Lease Sales 204, 207, 210, 215, and 218 in the Gulf of Mexico (MMS, 2007i). Resources analyzed applicable to this EIS/OEIS include coastal and marine birds; fisheries; fish resources and essential fish habitat; marine mammals, recreational fishing, sea turtles, seagrasses, and water quality. With the exception of an accidental event, no significant impacts are expected (MMS, 2007i). The central Gulf of Mexico portion of the 181 Area, was available for lease in Sale 205, which was held on October 3, 2007. The second additional sale area, "181 South," was analyzed in a Final Supplemental

Environmental Impact Statement (MMS, 2007k). Resources analyzed applicable to this EIS/OEIS include coastal and marine birds; fisheries; fish resources and essential fish habitat; marine mammals, recreational fishing, sea turtles, seagrasses, and water quality. With the exception of an accidental event, no significant impacts are expected (MMS, 2007k).

An Environmental Assessment (EA) was prepared by MMS to analyze whether any new information would result in a conclusion other than that presented in the Multisale EIS for proposed Lease Sale 206. It was determined that no additional analysis was necessary (MMS, 2007l).

To date, the only lease sales for 205, 206, 204, and 207 have been held. All others are tentatively scheduled for 2009 through 2012.

6.2.3.4 MMS Regulated Activities – Western Gulf of Mexico

Western Gulf Lease Sale 200 was held in August 2006. Mustang Island Area Blocks 793, 799, and 816 (off the southeastern coast of Texas) were included in this lease sale. These three blocks have been used by the Navy for equipment testing and MIW training exercises. However, the Navy did not object to these blocks being offered for lease under the condition of no surface occupancy. The following stipulations were added to operations in the naval MIW area:

(1) For below-seabed operations, the lessee agrees that no activity including, but not limited to, structures, drilling rigs, pipelines, and/or anchoring, will be located on the seabed or in the water column above within any portion of the lease. All exploration, development, and production activities or operations must take place from outside the lease by the use of directional drilling or other techniques.

(2) Prior to the submission of Exploration Plans and Development Operations Coordination Documents regarding any operations on or under the seabed of these blocks, the lessee will consult with the Commander, MIW Command, in order to determine the compatibility of the lessee's plans with scheduled military operations. The Explorations Plans and Development Operations Coordination Documents shall contain a statement certifying the consultation and indicating whether the Commander, MIW Command, has any objection to activities and schedule of the Explorations Plans and Development Operations Coordination Documents (MMS, 2006a).

The oil and gas pipeline network offshore of Gulf Coast states is extensive. Figure 6-3 shows the extent of actual and proposed pipelines as of April 2003. A few pipelines encroach on the westernmost edge of W-155 (Pensacola OPAREA).

6.2.4 State Regulated Oil and Gas Activities

The Submerged Lands Act of 1953 gives individual states the rights to marine natural resources from the coastline to no more than 5.6 km (3 NM) into the Atlantic Ocean and Gulf of Mexico. In Texas and the west coast of Florida, state jurisdiction extends from the coastline to no more than 16.2 km (3 marine leagues) into the Gulf of Mexico (MMS, 2007c). Natural resources beyond the abovementioned areas would be regulated by MMS. Therefore, any oil or gas activities occurring within 5.6 km (3 NM) of the coast would be state regulated.

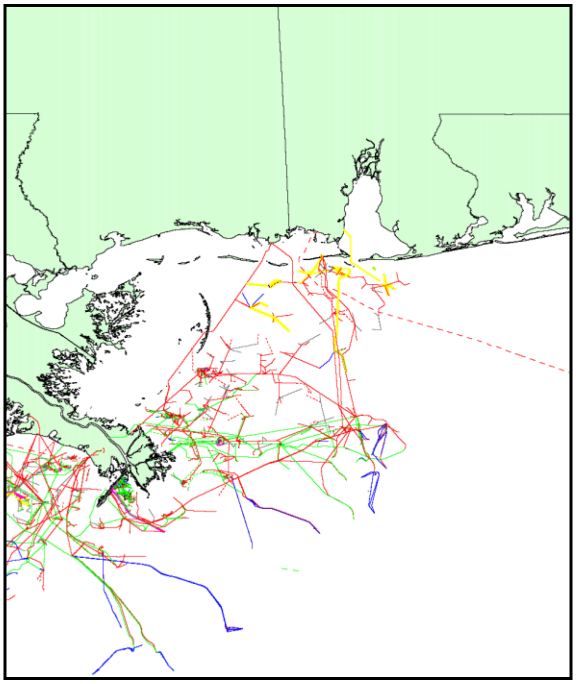


Figure 6-3. Actual and Proposed Pipelines Regulated by MMS
Source: MMS, 2003c

6.2.4.1 State Regulated – Atlantic Ocean, Offshore of the Southeastern United States

There are currently no state-regulated oil or gas activities in the Southeastern Atlantic Coast region of the United States (MMS, 2007h).

6.2.4.2 State Regulated –Atlantic Ocean, Offshore of the Northeastern United States

There are currently no state-regulated oil and gas activities within the Northeastern Atlantic Coast region of the United States. (MMS, 2007h).

6.2.4.3 State Regulated – Eastern Gulf of Mexico

The State of Florida has experienced very limited drilling in coastal waters. A moratorium has stopped all drilling activities in Florida waters, and there are no plans for future lease sales (MMS, 2003b).

Oil and gas activities conducted off the coast of states other than Florida are likely to have a similar suite of effects as those conducted in federal waters, but to a much lesser degree. Therefore, these activities are not expected to contribute significantly to the overall effects of oil and gas activities in the Gulf of Mexico.

6.2.4.4 State Regulated – Western Gulf of Mexico

Texas and Louisiana offer some lease sales in state waters, independent of the Federal OCS Program. Production has been in decline in recent years, while the number of wells has risen (MMS, 2003b; U.S. Air Force, 2004b). This trend is expected to continue. The State of Mississippi began offering tax breaks to companies in 1994 based on the types of discovery and the methods used. As a result, many inactive wells have been brought back into production and new wells have been drilled (U.S. Air Force, 2004b). Alabama has leased a limited number of tracts in state waters. However, the last lease sale was held in 1997, and further lease sales are not expected in the near future (MMS, 2003b).

6.2.5 Dredging Operations

The construction and maintenance of federal navigation channels are ongoing activities on the U.S. Atlantic coast and in the Gulf of Mexico. NMFS has identified dredging operations as an activity that may cause sea turtle mortality. Hopper dredges move faster than sea turtles and can entrain (or trap) them. NMFS has issued BOs with the U.S. Army Corps of Engineers (USACE) for the U.S. Atlantic coast and the Gulf of Mexico and has concluded that the implementation of reasonable and prudent measures will result in no jeopardy to sea turtle species. Dredging activities also have the potential to affect the protected Gulf and shortnose sturgeons, particularly juveniles that may not be able to avoid entrainment. This potential effect has not been quantified. Dredging operations obviously affect the geology of an area, as the floor topography is altered and turbidity occurs.

One area that requires channel maintenance dredging is the Thames River, which is used by Naval Submarine Base (NSB) New London, near Groton, Connecticut. In 2004, the U.S. Navy requested a permit for maintenance and improvement dredging from the USACE of the Thames River (USACE, 2005). Permit Number NAE-2004-3047 was granted May 2005 to remove piers 4, 6, and 13; construct a new pier 6; and dredge and construct a cad cell. The USACE does not have turtle monitoring/takes information for this area, but between 1994 and 2003, the Atlantic Ocean region of the United States had the fewest number of turtle takes (Dickerson et al., 2004).

An area on the mid Atlantic coast of the United States that utilizes maintenance dredging on a regular basis is the Hampton Roads region of southeastern Virginia. A Notice of Intent (NOI) to prepare an EIS for dredging the Norfolk Harbor Channel was announced in 2006. That EIS is being prepared so that 7.7 km (4.15 NM) of the channel could be deepened in order to provide Navy aircraft carriers with safe and unrestricted access. Hampton Roads, a natural tidal basin formed by the confluence of the James and Elizabeth Rivers, includes the waterways around Norfolk, Virginia Beach, Suffolk, Chesapeake, Portsmouth, Hampton, and Newport News, Virginia. A series of navigation channels (more than 10) lie in this area and require dredging to maintain their dimensions, which range from 107 to 305 m (350 to 1,000 ft) wide and 14 to 17 m (45 to 55 ft) deep (GlobalSecurity.org, 2005). The USACE Norfolk District has reported a total of 27 sea turtle takes between 2000 and 2006 due to dredging operations in the area of Hampton Roads (USACE, 2007c).

One southeastern Atlantic coast region in which maintenance dredging is necessary is within Cumberland Sound and NSB Kings Bay on the southeastern Georgia coast. Dredging in Kings Bay has occurred at least once a year since 1994. The USACE Jacksonville District has reported a total of 15 sea turtle takes between 2000 and 2007 due to dredging operations in the Kings Bay area (USACE, 2007e).

Another southeastern Atlantic coast area that requires maintenance dredging is Jacksonville Harbor and Naval Station (NS) Mayport in northeast Florida. In 2006 Jacksonville Port Authority (JAXPORT) deepened the final stretch of Jacksonville's main shipping channel from 11.5 to 12.2 m (38 to 40 ft). USACE is proposing to deepen the St. Johns River Main channel to

14 m (45 ft) (JAXPORT, 2007). To maintain adequate depths for naval ships, NS Mayport must dredge 458,732.92 cubic meters (m^3) (600,000 cubic yards [yd^3]) of sediment every 18 to 24 months from the entrance channel of the St. Johns River and the facility's turning basin (U.S. Environmental Protection Agency [EPA], 2000). Currently an EIS is being written by the Navy that proposes homeporting additional surface ships at NS Mayport. If that EIS is approved, it would require additional dredging to deepen the NS Mayport turning basin, the entrance channel, and the Jacksonville Harbor entrance channel and in addition would result in the removal and disposal of approximately 4,357,962.69 m^3 (5.7 million yd^3) of material (DON, 2006f). The USACE Jacksonville District has reported a total of six sea turtle takes between 2000 and 2007 due to dredging operations in the area of Jacksonville Harbor and NS Mayport (USACE, 2007e).

6.2.6 Maritime Traffic

6.2.6.1 Maritime Traffic – Commerce/Shipping Lanes

The waters off the U.S. Atlantic coast support a large volume of maritime traffic heading to and from foreign ports as well as traffic traveling north and south to various U.S. ports. Commercial shipping comprises a large portion of this traffic, and a number of commercial ports are located along the Atlantic and Gulf of Mexico U.S. coasts.

One of the primary shipping lanes in the northeastern Atlantic coast area is off northern New England with many arteries leading to ports in Massachusetts, New Hampshire, and Maine. Most of the eastern portion of the Boston OPAREA is free from commercial traffic, but commercial traffic can be expected in the western part of the OPAREA (DON, 2005). Several primary shipping lanes crisscross the Narragansett Bay OPAREA, leading to the major ports of New York City, New York and Newark, New Jersey, as well as Providence, Rhode Island. The Atlantic City OPAREA contains several primary shipping lanes leading from New York City and Newark to ports in Delaware Bay and the mid-Atlantic United States (DON, 2005). On July 1, 2007, in order to reduce the threat of vessel collisions with right and other whale species, NOAA and the USCG implemented a shift in the traffic separation scheme for Boston. Ships going in and out of Boston Harbor via shipping lanes will now travel a path that is rotated slightly to the northeast and narrowed. This lane shift adds about 6.9 km (3.75 NM) to the overall shipping lane distance (NOAA, 2007A).

A number of commercial ports are located in Chesapeake Bay and Delaware Bay in the mid-Atlantic U.S. coast area. There also are a number of inland ports that are accessed through these bay systems (DON, 2008m). The Virginia Capes (VACAPES) OPAREA is in the direct path of commercial shipping traffic traveling between the two major ports along the northeastern seaboard, New York and Boston, and Miami and other ports in the south (DON, 2008m).

The Cherry Point (CHPT) and Jacksonville/Charleston (JAX/CHASN) OPAREAs are also in the direct path of commercial shipping traffic traveling between New York, Boston, and Miami and other ports in the southeast. There are seven major shipping lanes in the JAX/CHASN and CHPT OPAREAs. Most of the lanes are parallel to the coastline but several branch off the main routes where they approach major shipping ports (DON, 2002b and 2002c).

A large volume of ship traffic navigates the Gulf of Mexico. Traffic includes ships traveling within the Gulf to ports in the United States and Mexico as well as in and out of the Gulf through the Florida Straits and Yucatan Channel. Commercial (domestic and international) shipping comprises the vast majority of this traffic. Nine primary shipping lanes radiate north from the Yucatan Straits into the Study Area while several major shipping lanes bisect the Florida Straits. Many large ports exist in the Gulf of Mexico area, the largest of which are Galveston, Texas; New Orleans, Louisiana; and Tampa, Florida (DON, 2007d).

Marine transportation is expected to grow. Surface vessel traffic is a major contributor to noise in all oceans, particularly at low frequencies. The effect on marine species is unknown, but it is possible that this persistent noise may affect marine mammals' use of sound for communication and hunting.

6.2.6.2 Maritime Traffic – Ship Strikes

NMFS identified commercial and recreational traffic and recreational pursuits as potentially having adverse effects on sea turtles and cetaceans through propeller and boat strike damage (U.S. Air Force, 2004b). Private vessels participating in high-speed marine activities are particular threats.

Ship strikes or ship collisions with whales are a recognized source of whale mortality worldwide. The most vulnerable marine mammals are those that spend extended periods of time at the surface in order to restore oxygen levels within their tissues after deep dives (e.g., the sperm whale). Laist et al. (2001) identified 11 species known to be hit by ships. These species include fin whales, right whales, humpback whales, sperm whales, and gray whales. Of these, fin whales are hit most frequently. On the East Coast of North America, ship strikes remain a significant threat to some whale populations. For North Atlantic right whales, for example, ship strikes are believed to be a significant factor limiting the recovery of this species (Knowlton and Kraus, 2001).

A review of recent reports on ship strikes provides some insight regarding the types of whales, locations and vessels involved, but also reveals significant gaps in the data. The Large Whale Ship Strike Database report provides a summary of the 292 worldwide confirmed or possible whale/ship collisions from 1975 through 2002 (Jenson and Silber, 2003). The report also notes that these totals represent a minimum number of collisions, because the vast majority go undetected or unreported.

All types of ships can hit whales, and in most cases the animal is either seen too late, not observed until the collision occurs, or not detected. The ability of a ship to avoid a collision and to detect a collision depends on a variety of factors, including environmental conditions, ship design, size, and number of crew.

Note that smaller ships, such as Navy destroyers and Coast Guard cutters, have a number of advantages for avoiding ship strikes compared to most merchant vessels. For instance, naval and Coast Guard ships have their bridges positioned forward, offering good visibility ahead of the bow.

Military crew sizes are also much larger than those of merchant ships, and they have dedicated lookouts posted during each watch. These vessels are generally twin screw and much more maneuverable than single screw commercial craft. Due to smaller ship size and higher deck manning, Navy and Coast Guard vessels are more likely to detect any strike that occurs, and these agencies' standard operating procedures include reporting of ship strikes. Overall, the percentage of Navy traffic relative to other large shipping traffic is very small (on the order of 2 percent).

NOAA continues to review all shipping activities and their relationship to cumulative effects, in particular on large whale species. According to the NOAA report (Jenson and Silber, 2003), the factors that contribute to ship strikes of whales are not clear, nor is it understood why some species appear more vulnerable than others. Nonetheless, the number of known ship strikes indicates that deaths and injuries from ships and shipping activities remain a threat to endangered large whale species, and to Atlantic Ocean right whales in particular (Jenson and Silber, 2003).

Maritime traffic also increases underwater noise. The amount of noise produced by a ship depends on its type, size, and operational mode. Large commercial vessels emit low frequency noise in ranges similar to those used by some large whales (mysticetes) in communication to each other (NMFS, 2006a). This communication between whales could be masked by vessel noise. Masking not only interferes with communication, but also with the animal's ability to detect and avoid approaching ships (NMFS, 2006a). Masking can be due to one individual ship or the constant drone in the ocean from increases in boat traffic. Boat traffic has steadily increased over the years; however, the number of large ships is predicted to double over the next two to three decades (Southall, 2005).

6.2.7 Seismic Survey and Scientific Research

Seismic surveys occur throughout the Study Area. One of the most active organizations performing oceanographic seismic surveys is the Lamont-Doherty Earth Observatory (LDEO). Seismic surveys performed by LDEO utilize airguns, sonar, and sub-bottom profilers, all of which have the possibility of harassing marine mammals. The deepwater Gulf of Mexico is the premier source of gas production intended to offset declines from gas fields on the shelf. Modern three-dimensional seismic surveys are the main survey method used for these efforts and sometimes cover hundreds of blocks and involve several months of acquisition time (Petzet, 1999). The OCS Deep Water Royalty Relief Act (DWRRA) provides economic incentives for operators to develop fields in water depths greater than 200 m (656.17 ft). Between 18 and 47 percent of the lease blocks in the Gulf of Mexico are undergoing geological surveys in any given year. During Gulf Cetaceans (GulfCet) I and II surveys, seismic exploration signals were detected 10 to 21 percent of the time, respectively (Davis et al., 2000a).

The potential exists for effects to protected marine mammals and sea turtles from underwater noise associated with seismic airgun surveys. LDEO has had Incidental Harassment Authorizations (IHAs) for surveys off the northern Yucatan Peninsula, northern Gulf of Mexico, southeast Caribbean Sea, and in the mid- and northwest Atlantic Ocean (Federal Register, 2004A, 2003A, 2004B, 2003B, and 2003C). However, these IHAs are all now expired. NMFS has determined that minor adverse behavioral effects to sea turtles may result from seismic survey activities in deeper federal waters, but these effects would be short-term and minor.

Effects to sea turtles have not yet been analyzed in states where nesting beaches and important foraging areas may be present (U.S. Air Force, 2005b).

In addition to seismic surveys, scientific research on protected species such as marine mammals and sea turtles and studies on the marine environment in general occur throughout the AFAST Study Area. For targeted research on particular species regulated by NMFS and the USFWS, a scientific research and enhancement permit is required for any proposed research activity that involves the "take" of a marine species. Scientific Research and Enhancement Permits are required for research that results in the take of marine mammal species or involves any ESA-listed species that are not covered by the General Authorization. Permits cover a five-year period. The most recent permit was issued by NMFS in August 2007 for activities being conducted by NMFS's Office of Science and Technology. The permit authorizes research on marine mammals in waters to the east of Andros Island, Bahamas. Activities include the attachment of tags to and photography of cetaceans, and exposing them to sound, particularly from mid-frequency sonar. Additional permits authorized that are of particular interest in the AFAST Study Area include a wide variety of research activities on right whales. NMFS is currently analyzing the cumulative effects of these authorizations in the proposed Programmatic EIS on Northern Right Whale Research.

The 1994 amendments to the MMPA authorized, under a General Authorization, the conduct of activities that involve low-impact harassment levels of marine mammals in the wild. Activities encompassed by the General Authorization for Scientific Research do not require a scientific research and enhancement permit. The activities covered under the General Authorization are limited to bona fide research that only involves Level B harassment of non-ESA-listed marine mammals and generally include, but are not limited to, photo-identification studies, behavioral observations, vessel surveys, and aerial surveys over water or land, as well as over pinniped rookeries if flown at altitudes greater than 305 m (1,000 ft) (NOAA, 1994). In addition to the General Authorization, NMFS also issues commercial and education photography permits. These permits allow for photography of non-listed marine mammals that result at a maximum in Level B harassment. Additional activities authorized include those related to imports for public display of marine mammals, as well as import and export of marine mammal parts.

6.2.8 Expended Materials

Expended materials include any man-made object expended, disposed of, or abandoned that enters the coastal or marine environment. It may enter directly from a ship, or indirectly when washed out to sea via rivers, streams, and storm drains. Types of expended materials include plastics, abandoned vessels, glass, metal, and rubber. These materials can injure or kill marine life, interfere with navigation safety, create adverse economic effects to shipping and coastal industries, and pose a threat to human health (NOAA, 2007i).

During the 2005 International Coastal Cleanup Campaign event, U.S. volunteers discovered 88 animals entangled in expended materials. As shown in Table 6-2, expended fishing line was responsible for nearly half of all entanglements, followed closely by rope and fishing nets (Ocean Conservancy, 2005a).

Table 6-2. Summary of Animals Entangled in Expended Materials

Material	Birds	Fish	Invertebrates	Mammals	Reptiles
Balloon ribbon/string	4	0	0	0	0
Fishing line	21	10	6	3	1
Fishing nets	8	3	1	0	1
Miscellaneous	1	2	1	0	2
Plastic bags	1	6	0	0	1
Plastic sheeting	1	1	0	0	0
Rope	5	2	1	6	0

Source: Ocean Conservancy, 2005a

6.2.9 Environmental Contamination and Biotoxins

Insufficient information is available to determine how, at what levels, or in what combinations, environmental contaminants may affect cetaceans (Marine Mammal Commission [MMC], 2003). There is growing evidence that high contaminant burdens are associated with several physiological abnormalities, including skeletal deformations, developmental effects, reproductive and immunological disorders, and hormonal alterations (Reijnders and Aguilar, 2002). DeSwart et al. (1996) conducted a study where harbor seals were fed contaminated Baltic herring and their immune function was monitored over a two-and-a-half-year period. The results of this study showed that chronic exposure to environmental contaminants accumulated through the food chain had an adverse effect on the immune function of those harbor seals. This further suggests that environmental contaminants may have an adverse immunological effect on free-ranging seals in areas with similar contamination levels as that observed in this study (DeSwart et al., 1996). Since no similar studies have been conducted with other marine mammal species, it may be reasonably concluded that similar effects could occur in other marine mammals, such as cetaceans.

Several mortality activities (die-offs) have been reported for cetaceans. Biotoxins, viruses, bacteria, and El Niño activities have been implicated separately in recent mass mortality activities (Domingo et al., 2002). A mass mortality activity for humpback whales, apparently associated with biotoxins, occurred along the beaches of Massachusetts in 1987 through 1988. Geraci et al. (1989) concluded that the whales died from saxitoxin poisoning after consumption of Atlantic mackerel containing the toxin. During the summer of 2003, 17 humpback whales, 3 fin whales, 1 minke whale, 1 long finned pilot whale, and 3 whales of undetermined species were found dead in the vicinity of Georges Bank. Although a biotoxin (saxitoxin) was found in several samples collected, it was not present at lethal levels. Domoic acid was also detected and suspected as a probable cause, but because no brain samples were collected, the role of this biotoxin could not be confirmed (MMC, 2004; DON, 2005).

6.2.10 Marine Tourism (Whale-Watching and Dolphin-Watching)

Migrating baleen whales may be affected by whale-watching activities off the East Coast as well as in the Caribbean (Hoyt, 1995). Effects of whale-watching on cetaceans may be measured in a short time-scale (i.e., startle reaction) or as a long-term effect on reproduction or survivability (International Fund for Animal Welfare [IFAW], 1995). There is little evidence to show that short-term effects have any relation to possible long-term effects on cetacean individuals, groups, or populations (IFAW, 1995). Whale-watching could have an effect on whales by distracting them, displacing them from rich food patches, or by dispersing food patches with wake or propeller wash.

6.2.11 National Aeronautics and Space Administration (NASA) Activities

The NASA's main operational centers on the East Coast are located at Kennedy Space Center and Cape Canaveral Air Force Station in Florida and Wallops Flight Facility/Goddard Space Flight Center in Virginia. Activities at the Florida sites in 2007 and 2008 include five space shuttle launches, and four Delta II rocket launches (NASA, 2007c). Operations at Wallops Flight Facility/Goddard Space Flight Center include many research-oriented activities such as the launching of sounding rockets and scientific balloons (NASA, 2007d).

The Wallops Flight Facility (WFF) is located on the Delmarva Peninsula in Virginia and is part of the NASA Goddard Space Flight Center. The WFF is compromised of the Main Base, Mainland, and Wallops Island. WFF is a multifaceted research and development facility with particular expertise in launching and utilizing sub-orbital rockets. It has been used as an aeronautics research center since 1945; WFF currently maintains three runways, an active launch range, communications and radar tracking systems, and approximately 556 buildings. The island covers an area of approximately 26.3 km^2 (10.2 mi^2).

An EA was completed in 2003 which proposed to make available for use the AQM-37 at Wallops Island (NASA, 2003). The AQM-37 is an air-launched, preprogrammed, nonrecoverable target with external command and control capabilities which can be used as an aerial target to test new and operational ship defense weapon systems. The purpose of the AQM-37 is to serve as a target for missile exercises being performed by the U.S. Navy and supported by WFF in the VACAPES OPAREA. This would be used to test the performance of shipboard weapons systems as well as provide simulated real-world targets for ship defense training exercises, allowing for the potential requirement of 20 target flights per year with a maximum of 30, which have been in place since 2003. After analyzing 14 environmental resources (land resources, water resources, air quality, noise, hazardous materials and waste, biological resources, population, recreation, employment and income, health and safety, cultural resources, environmental justice, transportation, and cumulative effects), NASA determined that there were no significant environmental impacts from the AQM-37 operations at WFF (NASA, 2003).

There is no additional publicly available information regarding past and present actions potentially occurring within the AFAST Study Area for this facility.

6.2.12 Military Operations

This section will discuss past and present military operations occurring within the AFAST Study Area. Specifically, the first three sections will discuss military exercises generally since these activities are associated with ESA Section 7 consultations with NMFS. In addition, this section will also discuss the Navy's Tactical Training Theater Assessment and Planning Program, which focuses on the sustainability of ranges, OPAREAs, and special use airspace within the AFAST Study Area.

6.2.12.1 Mine Exercise

Mine Exercises (MINEX) may occur as part of an Expeditionary Strike Group (ESG) Composite Training Unit Exercise (COMPTUEX) or a Combined Carrier Strike Group (CSG) COMPUTEX/ Joint Task Force Exercises (JTFEX), but they only involve underwater detonation (UNDET) activities when they are conducted as part of a Strike Group Training exercise on the East Coast. They do not involve mine laying or searching activities involving MIW sonar (this type of training conducted during ULT and Coordinated ULT in the Gulf of Mexico as part of a Gulf of Mexico Exercise [GOMEX] or squadron exercise [RONEX]). For an ESG COMPTUEX, UNDETs would occur in the CHPT box that is defined by the East Coast MINEX BO (up to 9 kg [20 lb] charges). For an ESG COMPTUEX, UNDETs would occur in the CHPT box that is defined by the East Coast MINEX BO (up to 9 kg [20 lb] charges). For the Combined CSG COMPTUEX/JTFEX the UNDETs would occur in CHASN in the box defined by the East Coast MINEX BO (NMFS, 2002a).

The potential biological effects associated with the MINEX UNDETs are addressed in the MINEX BO issued by NMFS in 2002. The BO addresses potential impacts from MIW exercises and explosive ordnance disposal (EOD) unit-level training to loggerhead, Kemp's ridley, leatherback, hawksbill, and green sea turtles at several locations along the East Coast (Virginia Beach, Virginia; Onslow Bay, North Carolina; and Charleston, South Carolina). The BO analyzed a total of 40 MINEX events per year to be conducted between the three locations using C-4 or high explosives as well as the possible use of 4.5 or 9.1 kg (10 or 20 lb) charges, in rare instances.

NMFS states in the BO that proposed MINEX and explosive ordnance disposal training is not likely to jeopardize the continued existence of loggerhead, Kemp's ridley, leatherback, hawksbill, and green sea turtles. However, NMFS anticipates incidental take of these species and has issued an Incidental Take Statement (ITS) pursuant to Section 7 of the ESA. The ITS includes mitigation measures with implementing terms and conditions to help minimize harassment. In addition, the BO states that species of large whales, including species protected by the ESA, can be found in or near the area where this type of training would occur. However, the BO states that NMFS feels that the protective measure identified within the BO, if implemented, would allow the Navy the opportunity to reduce the chances of effects to these species to discountable levels. Mitigation measures have been designed and implemented for MINEXs in order to minimize any potential adverse effects to marine mammals and to avoid any significant or long-term adverse effects to marine mammals and the coastal, cultural, or marine environment (NMFS, 2002a).

6.2.12.2 Sinking Exercise of Surface Targets

A Sinking Exercise of Surface Targets (SINKEX) is defined as the use of a vessel as a target or test platform against which live ordnance is fired. The purpose of a SINKEX is to train personnel, test weapons, and study the survivability of ship structures. The result is the sinking of the vessel. SINKEX operations differ from ship shock trials in that the warheads used in a SINKEX are significantly smaller. The environmental considerations of a SINKEX are associated with the weapons used. The exact amount of ordnance and the type of weapon used in a SINKEX is situational and training-need dependent (DON, 2006e).

The potential expended materials created during a SINKEX are metals from the sunken vessel and shell fragments. Disposable plastics and other materials that could be considered marine debris are removed from the vessel prior to conducting a SINKEX. Expended material associated with the target vessel would not include ropes, lines, plastic or other materials with the potential to ensnare or entangle marine animals. All expended materials would sink rapidly to the ocean floor and since SINKEXs would not be continuously conducted within the same areas the sunken debris would settle over a large area. The minimal amount of materials settling to the ocean floor would not affect the sediment stability of the ocean floor or cause disturbance to natural ocean processes (DON, 2006e).

In the late 1980’s, Polychlorinated biphenyls (PCBs) was raised as a potential environmental issue. Some of the materials (i.e., insulation, wiring, felts and rubber gaskets) present on the targeted vessels were confirmed to contain PCBs. As a result, the Navy has been removing the majority of the materials containing PCBs prior to conducting a SINKEX event. However, it is still estimated that even after removal activities any given target vessel sunk during a SINKEX could contain up to 45 kg (100 lbs) of PCBs. In an effort to determine if the remaining PCBs would be an environmental issue, the Navy begun conducting a PCBs monitoring study in 1995 on sunken Navy vessels. The monitoring study has not been completed but as of November 2006 it was determined that enough data had been gathered and transferred to the EPA to indicate that there was little likelihood that PCBs from sunken Navy vessels would present an unacceptable risk to the environment or human health. The Navy SINKEX Program currently holds a General Permit from the EPA under the Marine Protection, Research and Sanctuaries Act for conducting SINKEX activities (40 CFR 229.2).

The U.S. Navy submitted a Biological Assessment (BA) to the National Oceanic and Atmospheric Administration (NOAA) pursuant to compliance with the ESA. NOAA concluded that SINKEXs in the western Atlantic Ocean are not likely to jeopardize the continued existence of ESA listed species in a BO dated September 22, 2006 (NMFS, 2006i).

6.2.12.3 Naval Surface Fire Support Training

The Navy uses the Virtual At-Sea Training/Integrated Maritime Portable Acoustic Scoring and Simulator (VAST/IMPASS) system to qualify and recertify ships in naval surface fire support. The VAST/IMPASS system is a reusable, portable system that can be deployed anywhere in the open ocean. The system is comprised of five free-floating sonobuoys that are deployed in the shape of a pentagon/house array. The sonobuoys are capable of “scoring” the landing of 5-inch (in)/54 rounds aimed at a virtual target within the sonobuoy array. The buoys serve as collectors of acoustic information. When a 5-in/54 round impacts the water, accuracy is determined by the differential time that each individual buoy receives the sound (DON, 2005b).

The VAST/IMPASS system is used in open ocean areas along the eastern United States and in the Gulf of Mexico. Where live ordnance is used, the potential for marine mammal populations to be exposed to acoustic energy exists. Therefore, mitigation measures have been designed and implemented for the use of the VAST/IMPASS system to minimize any potential risks to marine mammals and to avoid any significant or long-term adverse effects to marine mammals and the coastal, cultural, and marine environment (DON, 2005b).

The Navy initiated formal consultation with NMFS in February 2004 by submitting a BA for use of the IMPASS system in East Coast OPAREAs and the Eastern Gulf of Mexico Test and Training Area (EGMTTA). The Navy is currently awaiting NMFS's BO, but anticipates that the conclusion will be that the use of naval gunfire is not likely to jeopardize the existence of any listed species. The mitigation/mitigation measures have and will continue to be implemented for use of the IMPASS system in order to minimize any potential risks to threatened and endangered species.

6.2.12.4 Military Operations – Atlantic Ocean, Offshore of the Southeastern United States

Designated bomb boxes have been established in each OPAREA where inert bombs could be dropped during a major Atlantic Fleet training exercise. The process for selecting these sites within each OPAREA involved balancing operational suitability (close proximity to where the strike group is operating) and environmental suitability. Environmental suitability includes an area that possesses a low likelihood of encountering threatened and endangered species and that avoids the continental shelf, canyon areas, and the Gulf Stream, all of which are locations where threatened and endangered marine mammal and sea turtle species are most abundant. The use of the bomb box (Area J31) in the JAX/CHASN OPAREA is discussed in the 1997 NMFS BO, which concludes that Navy activities are not likely to jeopardize the continued existence of listed species (NMFS, 1997). Based on the combination of prudent site-selection and the mitigation measures to be implemented in all OPAREAs that were developed as part of the BO for protection of the North Atlantic right whale (NMFS, 1997), it is anticipated that dropping inert bombs in the established bomb boxes associated with major Atlantic Fleet exercises would not affect listed species.

6.2.12.4.1 VACAPES Range Complex

The VACAPES Range Complex Draft EIS/OEIS was released in June 2008. The VACAPES Range Complex geographically encompasses offshore, near-shore, and onshore OPAREAs, ranges, and Special Use Airspace (SUA) located near the eastern coast of the United States. The VACAPES Range Complex is a set of operating and maneuver areas with defined ocean surface and subsurface areas. The surface water areas of the Range Complex covers the coast of Delaware, Maryland, Virginia, and North Carolina, encompassing 94,995.9 km^2 (27,661 NM^2). The shoreward extent of the OPAREA is roughly aligned with the 5.6 km (3 NM) state territorial limits. Due to the Navy's training requirements, the objective of the VACAPES Range Complex is to provide sustainable and modernized ocean operating areas, airspace, ranges, range infrastructure, training facilities, and resources to fully support the mission. The Study Area also serves as critical support for Navy operational readiness training and for RDT&E (DON, 2008d).

The Navy is preparing an EIS/OEIS to assess the potential environmental effects in the VACAPES Range Complex over a 10-year planning horizon. The Notice of Intent to prepare the EIS/OEIS, along with an announcement of scoping meetings, was published in the Federal Register on December 8, 2006. Four public scoping meetings were held in January 2007, and comments were received from December 8, 2006 to January 23, 2007. A revised Notice of Intent was published in the Federal Register on September 5, 2007, and public comments were received from September 5, 2007 to September 30, 2007. The VACAPES Draft EIS/OEIS was available for public comment beginning June 28, 2008 and public hearings were held in July

2008. The VACAPES Draft EIS/OEIS is incorporated by reference and is available for downloading/viewing via the internet at the following website address (http://www.vacapesrangecomplexeis.com). As stated in the VACAPES Range Complex EIS/OEIS, the No Action Alternative would continue current operations, including surge capabilities, consistent with the Fleet Response Training Plan (FRTP). For the purposes of this chapter, the No Action Alternative represents both past and present naval operations in the VACAPES Range Complex. Training operations in the VACAPES Range Complex range from unit-level exercises to integrated, major, range training events. A description of non-ASW training operations typically conducted in the VACAPES Range Complex can be found in Table 6-3.

Table 6-3. VACAPES Range Complex Typical Operations (Non-ASW)

Range Operation	Description
Mine Warfare (MIW)	
Mine countermeasures exercise	These exercises train forces to detect, identify, classify, mark, avoid, and disable (or verify destruction of) sea mines using a variety of methods, including, air, surface, and subsurface assets.
Mine neutralization	These operations involve the detection, identification, evaluation, rendering safe, and disposal of underwater unexploded ordnance (UXO) that constitute a threat to ships or personnel.
Surface Warfare (SUW)	
Bombing exercise (BOMBEX) (sea)	These exercises allow aircrew to train in the delivery of bombs against maritime targets.
Missile exercise (MISSILEX) (air-to-surface)	These exercises use laser and live fire to train fixed-wing aircraft and helicopter aircrews in the delivery of optical, infrared seeking, or laser guided missiles at surface targets.
Gunnery exercise (GUNEX) (air-to-surface)	Gunnery exercises train fixed-wing aircraft and helicopter aircrews to attack surface targets at sea using guns.
GUNEX (surface-to-surface) (boat)	In these exercises, small boat gun crews train by firing against surface targets at sea.
GUNEX (surface-to-surface) (ship)	Ship gun crews in these exercises train by firing against surface targets at sea.
Laser targeting	Laser targeting exercises are used to train aircraft personnel in the use of laser targeting devices to illuminate designated targets for engagement with laser-guided weapons.
Visit, Board, Search, and Seizure/Maritime Interdiction Operations (VBSS/MIO)-Ship	Crews from Navy helicopters and surface ships identify, track, intercept, board and inspect foreign merchant vessels suspected of not complying with United Nations/allied sanctions and/or conflict rules of engagement. The boarding party will be delivered from a surface ship via Rubber-hull Inflatable Boat (RHIB) or similar small craft if the target vessel is non-hostile, or via helicopter if hostile. This training event is non-firing.
Air Warfare (AW)	
Air combat maneuver (ACM)	ACM is the general term used to describe an air-to-air event involving two or more aircraft, each engaged in continuous proactive and reactive changes in aircraft attitude, altitude, and airspeed. No weapons are fired during ACM operations.
GUNEX (air-to-air)	In these training operations, guns are fired from aircraft against unmanned aerial target drones.
MISSILEX (air-to-air)	These are training operations in which air-to-air missiles are fired from aircraft against unmanned aerial target drones such as BQM-34 and BQM-74.
GUNEX (surface-to-air)	These operations are conducted by surface ships with 5-inch, 76 mm, and 20 mm Close-In Weapons System. Targets include unmanned drones or targets towed behind aircraft.

Table 6-3. VACAPES Range Complex Typical Operations (Non-ASW) Cont'd

Range Operation	Description
Air Warfare (AW) Cont'd	
MISSILEX (surface-to-air)	These operations train surface ship crews in defending against airplane and missile attacks with the ship's missiles. Missile firing ships, including guided missile cruisers, frigates, and destroyers, armed with surface-to-air missiles are required to engage each of three different presentations of aerial threats once per FRTP. The targets used are BQM-34, BQM-74, and GQM-163 Coyote.
Air intercept control	Surface ship and fixed-wing aircraft crew train in using their search radar capability to direct strike fighter aircraft toward threat aircraft.
Detect-to-engage	Shipboard personnel use all shipboard sensors (search and fire control radars and Electronic Support Measures (ESM)) in the entire process of detecting, classifying, and tracking enemy aircraft and/or missiles up to the point of engagement, with the goal of destroying the threat before it can damage the ship.
Strike Warfare (STW)	
High-Speed Anti-Radiation Missile Exercise (HARMEX) (air-to-surface)	Aircrews train in the use of High-Speed Anti-Radiation Missiles (HARM), the primary weapon designed to target anti-aircraft missile sites.
Amphibious Warfare (AMW)	
Firing exercise (FIREX) with Integrated Maritime Portable Acoustic Scoring and Simulator System (IMPASS)	FIREXs with IMPASS are training operations that direct naval gunfire to strike land targets and support military operations ashore. This training is conducted at-sea using a buoy system that simulates a land mass that a ship fires on using IMPASS.
Electronic Combat (EC)	
Chaff exercise	Chaff exercises train aircraft and shipboard personnel in the use of chaff to counter missile threats. Training and testing events are not necessarily dedicated sorties, but are combined with other exercises.
Flare exercises	These exercises train aircraft personnel in the use of flares for defensive purposes when countering heat-seeking missile threats. Training and testing events are not necessarily dedicated sorties, but are combined with other exercises.
Electronic combat operations	Ship-borne electronic combat operations or command and control warfare attempts to control critical portions of the electromagnetic spectrum.
Test and Evaluations	
Shipboard Electronic Systems Evaluation Facility (SESEF) utilization	SESEF operations test ship antenna radiation pattern measurements and communication systems.

Physical, biological, environmental, cultural, socioeconomic, and human resources were analyzed to determine the potential effects any expended materials would cause. It was determined that there will be no significant impact and no significant harm to physical, biological, environmental, cultural, socioeconomic or human resources due to the training activities occurring in the VACAPES Range Complex (DON, 2008d).

Acoustic analysis was performed to determine potential effects to marine mammals and sea turtles. Refer to Chapter 3 of the VACAPES Range Complex EIS/OEIS for a discussion of the methodology used to measure these effects. Acoustic analysis indicates that 63,664 total marine mammals (including ESA-listed species) may be exposed to levels of sound likely to result in

Level B harassment. Acoustic analysis also indicates that 728 total marine mammals (including ESA-listed species) may be exposed to levels of sound likely to result in Level A harassment. The analysis also indicates that the effect to 7 marine mammal mortalities may also result. The results of the acoustic analysis indicates the quantity of ESA-listed marine mammal species that may be exposed to levels of sound, 173 ESA-listed individuals may be exposed to levels of sound likely to result in Level B harassment and 1 ESA-listed species may be exposed to levels of sound likely to result in Level A harassment. The results also indicate the quantity of ESA-listed sea turtles that may be exposed to levels of sound, 11,340 species may result in Level B harassment, 42 may result in Level A harassment, and 2 may result in mortality. The exposure estimates for each alternative represents the total number of exposures and not necessarily the number of individuals exposed, as a single individual may be exposed multiple times over the course of a year (DON, 2008d). In addition, these exposure estimates do not include the incorporation of mitigation measures, which are designed to reduce exposure of marine mammals to potential impacts in an effort to achieve the least practicable adverse effect on marine mammal species or populations.

6.2.12.4.2 CHPT Range Complex

The CHPT Range Complex Draft EIS/OEIS was released in August 2008. The CHPT Range Complex geographically encompasses offshore and near-shore OPAREAs, instrumented ranges, and SUA located near the east coast of the United States. The CHPT Range Complex is a set of operating and maneuver areas with defined ocean surface and subsurface areas. The surface water area of the Range Complex covers the coast of North Carolina, encompassing 63,936.2 km^2 (18,617 NM^2). The shoreward extent of the Range Complex is roughly aligned with the 5.6 km (3 NM) state territorial limits. Due to the Navy's training requirements, the objective of the CHPT Range Complex is to provide sustainable and modernized ocean operating areas, airspace, ranges, range infrastructure, training facilities, and resources to fully support the mission. The Study Area is centrally located between the Atlantic Fleet concentration areas in Hampton Roads, Virginia and Jacksonville, Florida, and the Marine Forces Atlantic concentrations areas in North Carolina, making it the primary venue for all levels of amphibious training and intermediate and advanced levels of CSG, ESG, and MEU training (DON, 2008f).

The Navy is preparing an EIS/OEIS to assess the potential environmental effects in the CHPT Range Complex over a 10-year planning horizon. The Notice of Intent to prepare the EIS/OEIS, along with an announcement of scoping meetings, was published in the Federal Register on April 30, 2007. Two public scoping meetings were held in May 2007, and comments were received from April 30, 2007 to June 12, 2007. The CHPT Draft EIS/OEIS was available for public comment beginning September 12, 2008 and public hearings were held in October 2008. The public comment period closed on October 27, 2008. The CHPT Draft EIS/OEIS is incorporated by reference and is available for downloading/viewing via the internet at the following website address: (http://www.navycherrypointrangecomplexeis.com). As stated in the Navy CHPT Range Complex EIS/OEIS, the No Action Alternative would continue current operations, including surge capabilities, consistent with the FRTP. For the purposes of this chapter, the No Action Alternative represents both past and present naval operations in the CHPT Range Complex. Training operations in the CHPT Range Complex can vary from unit level exercises to integrated major range training events. A description of non-ASW training operations typically conducted in the CHPT Range Complex can be found in Table 6-4 (DON, 2008f).

Table 6-4. CHPT Range Complex Typical Operations (Non-ASW)

Range Operation	Description
Mine Warfare (MIW)	
Mine countermeasures (MCM)	Helicopters, surface and subsurface units detect, identify, classify, mark, disable and/or destroy sea mines using a variety of methods.
Mine neutralization	Helicopters, surface, and subsurface units, and EOD personnel identify, evaluate, localize and destroy or render safe sea mines that constitute a threat to ships, landing craft or personnel.
Surface Warfare (SUW)	
Bombing Exercise (Sea) (BOMBEX A-S)	Fixed wing aircraft deliver bombs against maritime targets.
Missile Exercise (Air-to-Surface)	Air-to-Surface Missile Exercise (Laser and Live Fire) [MISSILEX (A-S)] trains fixed-wing aircraft and helicopter aircrews in the delivery of optical, infrared seeking or laser guided missiles at surface targets.
Gunnery Exercise (Air-to-Surface)	Air-to-Surface Gunnery Exercise (GUNEX) trains fixed-wing aircraft and helicopter aircrews to attack surface targets at sea using guns.
Gunnery Exercise Ship (Surface-to-Surface) (GUNEX S-S (Ship))	Surface ships fire main battery guns and crew-served weapons against maritime targets.
Visit, Board, Search, and Seizure/Maritime Interdiction Operations (VBSS/MIO)-Ship and Helo	Crews from Navy helicopters and surface ships identify, track, intercept, board and inspect foreign merchant vessels suspected of not complying with United Nations/allied sanctions and/or conflict rules of engagement. The boarding party will be delivered from a surface ship via Rubber-hull Inflatable Boat (RHIB) or similar small craft if the target vessel is non-hostile, or via helicopter if hostile. This training event is non-firing.
Air Warfare (AW)	
Air Combat Maneuver (ACM)	Two or more aircraft engaged in continuous proactive and reactive changes in aircraft attitude, altitude, and airspeed in an attempt to destroy the opposition. Fighter aircraft do fire live weapons during ACM, just not in a training environment.
GUNEX (Air-to-Air)	GUNEX Air-to-Air training operations in which guns are fired from aircraft against unmanned aerial target drones.
MISSILEX (Air-to-Air)	Air-to-Air Missile Exercise [MISSILEX (A-A)] are training operations in which air-to-air missiles are fired from aircraft against unmanned aerial target drones such as BQM-34 and BQM-74.
Air Intercept Control (AIC)	Surface ships vector friendly aircraft to intercept and destroy adversary aircraft.
Electronic Combat (EC)	
Electronic Combat Operations (EC)	Aircraft, surface ships, and submarines attempt to control critical portions of the electromagnetic spectrum to degrade or deny the enemy’s ability to defend its forces from attach and/or recognize an emerging threat early enough to take the necessary defensive actions.
Chaff Exercise	Shipa and aircraft deploy chaff to disrupt threat targeting and missile guidance radars and to defend against an attack.

Table 6-4. CHPT Range Complex Typical Operations (Non-ASW) Cont'd

Range Operation	Description
Electronic Combat (EC), Cont'd	
Flare Exercise	Aircraft deploy flares to disrupt threat infrared guidance systems of threat missiles.
Strike Warfare (STW)	
High-Speed Anti-Radiation Missile Exercise (HARMEX) (air-to-surface)	Aircraft crews train in the use of High-Speed Anti-Radiation Missiles (HARM), the primary weapon designed to target anti-aircraft missile sites.
Amphibious Warfare (AMW)	
Firing Exercise (FIREX)-Land (FIREX (Land))	Surface ships fire main battery guns against land targets in support of military operations ashore.
FIREX – Integrated Maritime Portable Acoustic Scoring and Simulator System (IMPASS)	Surface ships fire main battery guns against land targets in support of military operations ashore. This training is conducted at-sea using a computer simulated land target and a series of buoys that can acoustically score the training event.
Amphibious Assault	A Marine Battalion Landing Team (typically two reinforced companies, including armor and service support units) move ashore from the Expeditionary Strike Group at-sea to establish a beachhead in hostile territory, then moves further inland for an extended period. Ingress via amphibians, landing craft and/or rotary-wing aircraft. Coordinated fire support from aircraft, surface ships and artillery.
Firing Exercise (FIREX)-Land (FIREX (Land))	Surface ships fire main battery guns against land targets in support of military operations ashore.
Amphibious Raid	A reinforce company (100-150 Marines) makes a swift, short-term incursion from the Expeditionary Strike Group at-sea to a hostile area ashore for a specified purpose and a specified time, then makes a planned withdrawal. Ingress and extraction via small boats, amphibians, landing craft and/or helicopters.

Physical, biological, environmental, cultural, socioeconomic, and human resources were analyzed to determine the potential effects any expended materials would cause. It was determined that there will be no significant impact and no significant harm to physical, biological, environmental, cultural, socioeconomic or human resources due to the training activities occurring in the Cherry Point Range Complex (DON, 2008f).

Acoustic analysis was performed to determine potential effects to marine mammals and sea turtles. Refer to Chapter 3 of the Navy Cherry Point Range Complex Draft EIS/OEIS for a discussion of the methodology used to measure these effects. Acoustic analysis indicates that 2,877 total marine mammals (including ESA-listed species) may be exposed to levels of sound likely to result in Level B harassment. Acoustic analysis also indicates that 65 total marine mammals (including ESA-listed species) may be exposed to levels of sound likely to result in Level A harassment. No mortalities are predicted due to active sonar activities. The results of the acoustic analysis indicates the quantity of ESA-listed marine mammal species that may be exposed to levels of sound, 4 ESA-listed species may be exposed to levels of sound likely to result in Level B harassment. The results also indicate the quantity of ESA-listed sea turtles that may be exposed to levels of sound, 137 species may result in Level B harassment and 3 may result in Level A harassment. The exposure estimates for each alternative represents the total number of exposures and not necessarily the number of individuals exposed, as a single individual may be exposed multiple times over the course of a year (DON, 2008f). These exposure estimates do not include the incorporation of mitigation measures, which are designed to reduce exposure of marine mammals to potential impacts in an effort to achieve the least practicable adverse effect on marine mammal species or populations.

6.2.12.4.3 JAX/CHASN Range Complex

JAX Range Complex EIS/OEIS

The JAX Range Complex Draft EIS/OEIS was released in June 2008. The JAX Range Complex geographically encompasses offshore, near-shore, and onshore OPAREAs, ranges, and Special Use Airspace (SUA) located near the east coast of the United States. The JAX Range Complex, which covers both the Charleston and Jacksonville Range Complexes, is a set of operating and maneuver areas with defined ocean surface and subsurface areas. The surface water area of the Range Complex covers the coast of South Carolina, Georgia, and Florida, encompassing 172,023.6 km^2 (50,090 NM^2). The shoreward extent of the OPAREA is roughly aligned with the 5.6 km (3 NM) state territorial limits. Due to the Navy's training requirements, the objective of the JAX/CHASN Range Complex is to provide sustainable and modernized ocean operating areas, airspace, ranges, range infrastructure, training facilities, and resources to fully support the mission. The Study Area also serves as critical support for Navy operational readiness training and for RDT&E of emerging maritime and combat technologies (DON, 2008e).

The Navy is preparing an EIS/OEIS to assess the potential environmental effects in the JAX Range Complex over a 10-year planning horizon. The Notice of Intent to prepare the EIS/OEIS, along with an announcement of scoping meetings, was published in the Federal Register on January 26, 2007. Four public scoping meetings were held in February 2007, and comments were received from January 26, 2007 to March 13, 2007. The JAX Draft EIS/OEIS was available for public comment beginning June 28, 2008 and public hearings were held in July 2008. The JAX Draft EIS/OEIS is incorporated by reference and is available for downloading/viewing via the internet at the following website address: (http://www.jacksonvillerangecomplexeis.com). As stated in the JAX Range Complex EIS/OEIS, the No Action Alternative would continue current operations, including surge capabilities, consistent with the FRTP. For the purposes of this chapter, the No Action Alternative represents both past and present naval operations in the JAX Range Complex. Training operations in the JAX/CHASN Range Complex are very similar to the training performed at the VACAPES Range Complex; they can vary from unit level exercises to integrated major range training events. A description of non-ASW training operations typically conducted in the JAX Range Complex can be found in Table 6-5 (DON, 2008e).

Physical, biological, environmental, cultural, socioeconomic, and human resources were analyzed to determine the potential effects any expended materials would cause. It was determined that there will be no significant impact and no significant harm to physical, biological, environmental, cultural, socioeconomic or human resources due to the training activities occurring in the JAX/CHASN Range Complex (DON, 2008e).

Table 6-5. JAX/CHASN Range Complex Typical Operations (Non-ASW)

Range Operation	Description
Mine Warfare (MIW)	
Mine Laying	Airborne mine-laying training uses two types of training operations: Mine Exercises (MINEX) and Mine Readiness Certification Inspections. In the typical mining training profile, MINEXs usually involve a single aircraft sortie planting several inert training mine shapes in the water. The aircrew drops a series of (usually four) inert training shapes in the water.
Mine countermeasures	Mine Countermeasure (MCM) exercises train forces to detect, identify, classify, mark, avoid, and disable (or verify destruction of) sea mines using a variety of methods, including, air, surface, and subsurface assets.
Mine neutralization	Mine Neutralization operations involve the detection, identification, evaluation, rendering safe, and disposal of underwater unexploded ordnance that constitute a threat to ships or personnel.
Surface Warfare (SUW)	
MISSILEX (A-S)	MISSILEX (A-S) (Live Fire) trains aircraft and helicopter crews in the delivery of optical, infrared seeking, or laser guided missiles (Hellfire and Maverick) at surface targets.
GUNEX (A-S)	GUNEX (A-S) trains aircraft and helicopter crews to attack surface targets at sea using guns.
GUNEX (S-S)	GUNEX (S-S) trains ship gun crews by firing against surface targets at sea.
BOMBEX (sea)	BOMBEX (sea) allows aircrew to train in the delivery of bombs against maritime targets.
Laser targeting	MISSILEX (A-S) (Laser Only) trains aircraft or helicopter crews in the delivery of optical, infrared seeking or laser guided missiles at surface targets. This operation does not result in live missile fire, only discrimination of the target and illumination of the target with a laser.
Visit, Board, Search, and Seizure/Maritime Interdiction Operations (VBSS/MIO)-Ship	Non-firing ULT and major exercise events. Each ship must conduct one VBSS/MIO every six months. Target vessel is typically another strike group ship or Mobile Sea Range (MSR) vessel such as Prevail.
VBSS/MIO-Helicopter	Non-firing ULT & major exercise events. NSW personnel fast-rope onto target vessel from 1st helicopter. 2nd helicopter flies close cover, and 3rd helicopter flies surveillance.
GUNEX (S-S) (Fast Attack Craft/Fast Inshore Attack Craft [FAC/FIAC])	Non-firing major exercise event only. Typically involves multiple ships prosecuting multiple targets (High Speed Maneuverable Seaborne Targets or other small craft) during a choke point transit event.
Air Warfare (AW)	
ACM	ACM is the general term used to describe an air-to-air (A-A) event involving two or more aircraft, each engaged in continuous proactive and reactive changes in aircraft attitude, and airspeed. No live weapons are fired during ACM operations.
Air Intercept Control	Surface ships and fixed wing aircraft train in using their search radar capability to direct strike fighter aircraft toward threat aircraft.
ACM Chaff Exercise	Chaff exercises train shipboard personnel and helicopter crews in the use of chaff to counter missile threats. Training and testing evens not necessarily dedicated events, but combined with other exercises.
ACM Flare Exercise	Trains aircraft personnel in the use of flares for defensive purposes when countering heat-seeking missile threats. Training and testing events not necessarily dedicated sorties, but may be combined with other exercises.

Table 6-5. JAX/CHASN Range Complex Typical Operations (Non-ASW) Cont'd

Range Operation	Description
Air Warfare (AW) Cont'd	
MISSILEX (A-A)	MISSILEX (A-A) are training operations in which air-to-air AIM missiles are fired from aircraft (live and non-explosive) against unmanned aerial target drones such as BWM-34 and BQM-74.
GUNEX (S-A)	GUNEXs (S-A) are conducted by surface ships with 5-inch, 76mm and 20mm Close In Weapons Systems. Targets include unmanned drone as well as targets towed behind aircraft.
Detect-to-Engage	Shipboard personnel use all shipboard sensors (search and fire control radars and Electronic Support Measures (ESM)) in the entire process of detecting, classifying, and tracking enemy aircraft and/or missiles up to the of engagement, with the goal of destroying the threat before it can damage the ship.
Strike Warfare (STW)	
FIREX with Integrated Maritime Portable Acoustic Scouring and Simulator System (IMPASS)	Surface-to-surface gunnery exercises with IMPASS are training operations that direct naval gunfire to strike land targets and support military operations ashore. This training is conducted at-se using a computer-simulated land target and a series of buoys that can acoustically score the training event.
BOMBEX (A-G)	BOMBEXs (Land) allow aircrews to train in the delivery of bombs against ground targets.
Combat Search and Rescue (CSAR) and Convoy Operations	CSAR operations train rescue forces personnel the tasks needed to be performed to affect the recovery of distressed personnel during war or military operations other than war.
Electronic Combat (EC)	
EC Operations	Air or ship crews attempt to control critical portions of the electronic spectrum used by threat radars, communications equipment, and electronic detection equipment to degrade or deny enemy attacks.
Chaff Exercise	Exercises train aircrews the use of chaff to counter enemy threats by creating radar reflective false targets. Chaff may also be used offensively by aircrews or shipcrews to hide inbound striking aircraft or ships.
Flare Exercise (Aircraft Self-Defense)	Fixed-wing aircraft and helicopters deploy flares to disrupt threat infrared missile guidance systems to defend against an attack.
Other Training	
Shipboard Electronic Systems Evaluation Facility Utilization (SESEF)	SESEF operations test ship antenna radiation pattern measurements and communications systems.

Physical, biological, environmental, cultural, socioeconomic, and human resources were analyzed to determine the potential effects any expended materials would cause. It was determined that there will be no significant impact and no significant harm to physical, biological, environmental, cultural, socioeconomic or human resources due to the training activities occurring in the JAX/CHASN Range Complex (DON, 2008e).

Acoustic analysis was performed to determine potential effects to marine mammals and sea turtles. Refer to Chapter 3 of the Jacksonville Range Complex EIS/OEIS for a discussion of the methodology used to measure these effects. Acoustic analysis indicates that 1,126 total marine mammals (including ESA-listed species) may be exposed to levels of sound likely to result in Level B harassment. Acoustic analysis also indicates that 31 total marine mammals (including ESA-listed species) may be exposed to levels of sound likely to result in Level A harassment.

The results of the acoustic analysis indicates the quantity of ESA-listed marine mammal species that may be exposed to levels of sound, 1 ESA-listed species may be exposed to levels of sound likely to result in Level B harassment. No mortalities are predicted due to the active sonar activities. The results also indicate the quantity of ESA-listed sea turtles that may be exposed to levels of sound, 444 species may result in Level B harassment and 10 may result in Level A harassment. The exposure estimates for each alternative represents the total number of exposures and not necessarily the number of individuals exposed, as a single individual may be exposed multiple times over the course of a year (DON, 2008e). These exposure estimates do not include the incorporation of mitigation measures, which are designed to reduce exposure of marine mammals to potential impacts in an effort to achieve the least practicable adverse effect on marine mammal species or populations.

NSB Kings Bay

NSB Kings Bay, Georgia, is located in coastal southeastern Georgia, along the western shore of Cumberland Sound approximately 3 km (2 mi) north of St. Mary's, Georgia and approximately 56 km (35 mi) north of Jacksonville, Florida. The site was designated as NSB Kings Bay in 1982, and encompasses approximately 65 km^2 (25 mi^2). Facilities at the base enable Kings Bayto serve as a homeport, refit site, and training facility for the Navy personnel who operate and maintain the Ohio-class submarines (GlobalSecurity.org, 2007d).

The Navy Strategic Systems Programs proposed to construct and maintain security facilities to support continuous security service and incident response at NSB Kings Bay. Security improvements include a Waterfront Security Force Facility, an Auxiliary Reaction Force Facility, an Armored Fighting Vehicle Operational Storage Facility (AFVOSF); an Armory; road improvements to ensure efficient access to and from the proposed facilities; and construction of a new parking lot to replace lost parking spaces. No significant effects to environmental resources were expected.

NS Mayport

NS Mayport is located near the Port of Jacksonville on the St. Johns River in northeast Florida. NS Mayport is home to 55 tenant commands and private organizations. Some two dozen ships are berthed in the Mayport basin, including Airborne Early Warning/Ground Environment Integration Segment (AEGIS) guided-missile cruisers, destroyers, guided-missile frigates, and aircraft carriers (GlobalSecurity.org, 2007e). NS Mayport covers 14 km^2 (5 mi^2) and is the third largest naval facility in the continental United States. NS Mayport is unique in that it is home to a busy seaport as well as an air facility that conducts more than 135,000 flight operations each year (GlobalSecurity.org, 2007e).

6.2.12.4.4 Mesa Verde Ship Shock Trial

As of May 2008, The Mesa Verde Ship Shock Trial EIS/OEIS was finalized in May 2008 (DON, 2008g). The EIS/OEIS analyzed three alternative offshore locations (Mayport, Florida; Norfolk, Virginia; and Pensacola, Florida) considering variability in terms of marine species and status (e.g., threatened and endangered) as well as differences with respect to potential impacts (i.e., different mortality, injury, and behavioral disturbance ranges and sensitivities to impact). Even though all three locations met the minimal operational requirements, the Mayport, Florida location was chosen to conduct a shock trial in spring/summer 2008 with protective measures in place to minimize risk to marine mammals and sea turtles. Based on the Navy's requirement to test the MESA VERDE before deployment due to the available schedule, Mayport, Florida was found the best option to meet the projects purpose and need, satisfy operational requirements, and minimize environmental impacts. Shock trials are not to be conducted offshore Mayport until after May 1, 2008 due to migratory patterns of North Atlantic right whales. The proposed shock trial and associated protective measures will be taking place 70.4 km (38 NM) off the coast of Mayport, Florida, occupying a surface water area of 15,928 km^2 (4,643 NM^2) and includes offshore and nearshore locations (DON, 2008g).

Physical, biological, environmental, cultural, socioeconomic, and human resources were analyzed to determine the potential effects any expended materials would cause. It was determined that there will be no significant impact and no significant harm to physical, biological, environmental, cultural, socioeconomic or human resources due to the training activities occurring in the Mayport Study Area (DON, 2008g).

Acoustic analysis was performed to determine potential effects to marine mammals and sea turtles. Refer to Chapter 4 of the Mesa Verde Ship Shock Trial EIS/OEIS for a discussion of the methodology used to measure these effects. Acoustic analysis indicates that 489 total marine mammals (including ESA-listed species) may be exposed to levels of sound likely to result in Level B harassment. Acoustic analysis also indicates that 8 total marine mammals (including ESA-listed species) may be exposed to levels of sound likely to result in Level A harassment. The analysis also indicates that the effect to 1 marine mammal mortalities may also result. The results of the acoustic analysis indicate that no ESA-listed marine mammal species will be exposed or injured due to the training activities. The results also indicate the quantity of ESA-listed sea turtles that may be exposed to levels of sound, 2,079 species may result in Level B harassment, 46 may result in Level A harassment, and 1 may result in mortality. The exposure estimates for each alternative represents the total number of exposures and not necessarily the number of individuals exposed, as a single individual may be exposed multiple times over the course of a year. The Navy finds that ESA-listed species may experience a cumulative impact from AFAST active sonar activities; however, they are not expected to adversely affect the populations of ESA-listed species (DON, 2008g).

6.2.12.5 Military Operations –Atlantic Ocean, Offshore of the Northeastern United States

The Northeast Range Complex is located of the northeast coast of the United States and is made up of the Boston OPAREA, Narragansett OPAREA, and Atlantic City OPAREA. The surface water area of the OPAREA covers the coast of Delaware, New Jersey, New York, Connecticut, Rhode Island, Massachusetts, New Hampshire, and Maine. The activities being performed in the Northeast OPAREA consist of aerial inert bombing exercises being conducted by P-3 aircraft out of NAS Brunswick in W-102 East. These activities would be taking place in an existing Warning Area 22.3 km (12 NM) and seaward off the northeast coast of the United States. Activities are expected to continue in the area through 2009, at which point the P-3s will be relocating to Jacksonville, FL, which will eliminate the need for inert bombing activities in W-102 East (DON, 2008h).

Physical, biological, environmental, cultural, socioeconomic, and human resources were analyzed to determine the potential effects any expended materials would cause. It was determined that there will be no significant impact and no significant harm to physical, biological, environmental, cultural, socioeconomic or human resources due to the training activities occurring in the Northeast Range Complex (DON, 2008h).

6.2.12.6 Military Operations – Eastern Gulf of Mexico

6.2.12.6.1 GOMEX Range Complex

The GOMEX Range Complex geographically encompasses offshore, near-shore, and onshore OPAREAs, ranges, and SUA located near the Gulf Coast of the United States. The GOMEX offshore OPAREAs are a set of operating and maneuver areas with defined ocean surface and subsurface areas. The surface water areas of the Range Complex covers the coast of Texas, Louisiana, Mississippi, Alabama, and the Northwestern Coast of Florida. Furthermore, there are four OPAREAs associated with the GOMEX Range Complex, which are Panama City, Pensacola, New Orleans, and Corpus Christi, encompassing 59,894 km^2 (17,440 NM^2). The shoreward extent of the Range Complex is roughly aligned with the 5.6 km (3 NM) state territorial limits. Due to the Navy's training requirements, the objective of the GOMEX Range Complex is to provide sustainable and modernized ocean operating areas, airspace, ranges, range infrastructure, training facilities, and resources to fully support the mission, as well as providing critical support for Navy operational readiness training and for RDT&E (DON, 2008i).

The Navy is currently preparing a Draft EIS/OEIS to assess the potential environmental effects in the GOMEX Range Complex over a 10-year planning horizon. As presented in the information provided on the GOMEX Range Complex website, the No Action Alternative would continue current operations, including surge capabilities, consistent with the FRTP. For the purposes of this chapter, the No Action Alternative represents both past and present naval operations in the GOMEX Range Complex. Training operations in the GOMEX Area range from unit-level exercises to integrated, major, range training events. A description of non-ASW training operations typically conducted in the Range Complex can be found in Table 6-6 (DON, 2008i).

Table 6-6. GOMEX Range Complex Typical Operations (Non-ASW)

Range Operation	Description
Mine Warfare (MIW)	
Mine Countermeasures - Airborne	Helicopters, surface and subsurface units detect, identify, classify, mark, disable, and/or destroy sea mines using a variety of methods.
Mine Countermeasures – Surface	
Mine Neutralization-Remotely Operated Vehicle	Helicopters, surface and subsurface units, and EOD personnel identify, evaluate, localize, and destroy or render safe sea mines that constitute a threat to ships, landing craft or personnel.
Mine Neutralization-Explosive Ordnance Disposal	

Table 6-6. GOMEX Range Complex Typical Operations (Non-ASW) Cont'd

Range Operation	Description
Surface Warfare (SUW)	
Bombing Exercise (BOMBEX) Air-to-Surface (A-S)	Fixed wing aircraft deliver bombs against maritime targets.
Gunnery Exercise (GUNEX) (Air-to-Surface)	Fixed wing aircraft deliver gunfire against maritime targets.
GUNEX [Surface-to-Surface (S-S)] – Ship	Surface ships fire main battery guns and crew-served weapons against maritime targets.
GUNEX [Surface-to-Surface(S-S)] - Boat	Small boat gun crews train by firing small arms or dropping grenades against surface targets at sea.
Air Warfare (AW)	
Air Intercept Control	Surface ships vector friendly aircraft to intercept and destroy adversary aircraft.
Strike Warfare (STW)	
BOMBEX (Air-to-Ground)	Fixed wing aircraft deliver bombs against land targets.
GUNEX (Air-to-Ground)	Fixed wing aircraft deliver gunfire against land targets.
Amphibious Warfare (AMW)	
Firing exercise (FIREX) - Integrated Maritime Portable Acoustic Scoring and Simulator System (IMPASS)	Surface ships fire main battery guns against land targets in support of military operations ashore. This training is conducted at-sea using a computer simulated land target and a series of buoys can acoustically score the training event.
Range Operation	**Description**
Electronic Combat (EC)	
Chaff Exercise – Ship Deployed Chaff	Ships deploy chaff to disrupt threat targeting and missile guidance radars and to defend against an attack.
Chaff Exercise – Aircraft Deployed Chaff	Aircraft deploy chaff to disrupt threat targeting and missile guidance radars and to defend against an attack.
Flare Exercise	Aircraft deploy flares to disrupt infrared guidance systems of threat missiles.
Flight Maneuver Training	Aircraft engage in continuous proactive and reactive changes in aircraft attitude, altitude, and airspeed. No HE weapons are fired during the training.
Basic Flight Instruction	Student pilots engage in continuous proactive and reactive changes in aircraft attitude, altitude, and airspeed. No HE weapons are fired during the training.
Salvage Diver Training	Salvage divers train in the use of small underwater charges.
EOD Tech Training	Explosive Ordnance Disposal technicians train in the use of small underwater charges.
Security Force Training	Security Forces train in the detonation of small underwater charges.
Diver Training	Divers train in the use of small underwater charges.

Physical, biological, environmental, cultural, socioeconomic, and human resources will be analyzed to determine the potential effects any expended materials would cause.

6.2.12.6.2 Amphibious Ready Group/Marine Expeditionary Unit Readiness Training

In 2003, the Navy and Marine Corps conducted one readiness training exercise at Eglin AFB. Fleet Forces Command does not plan to conduct this training at Eglin AFB in the near future.

Transport of the Marine Expeditionary Unit (MEU) was conducted by naval ships from various locations throughout the United States to the Gulf of Mexico. Amphibious Ready Group (ARG) operations occurred within the Inner Transport Area, which covers an 8 by 32 km (5 by 20 mi) rectangular box approximately 1.9 to 11 km (1 to 7 mi) from the beach. During the 10-day exercise, ARG ships remained in the assigned box at slow speed (5 to 10 knots [5.8 to 11.5 miles per hour]) or at anchor (U.S. Marine Corps et al., 2003). Operations included launch/recovery of aircraft and launch/recovery of Landing Craft Air Cushion (LCAC), Landing Craft Utility (LCU), and Amphibious Assault Vehicles (AAVs). The ARG consisted of three amphibious ships that were augmented by two or three cruisers/destroyers. No ship-to-shore movements of ground forces occurred from cruisers and destroyers and no more than seven aircraft operated during a single activity (U.S. Marine Corps et al., 2003).

Potential effects from ARG/MEU operations included noise, socioeconomic effects, and effects to biological resources, particularly to protected species (U.S. Marine Corps et al., 2003). During the 10-day period of exercises, approximately 130 crossings of LCACs between Navy ships and shore, 78 crossings by AAVs, and 42 crossings by LCUs occurred. These crossings had the potential to transmit noise into the marine environment, potentially disturbing marine species such as sea turtles and marine mammals (U.S. Marine Corps et al., 2003). In addition, there was a potential for vessels to physically strike some animals.

The number of sea turtles potentially affected by surface vessels was evaluated in the BA for ARG/MEU activities and is summarized in Table 6-7.

Table 6-7. Sea Turtles Potentially Affected by ARG/MEU Activities

Species	Number of Sea Turtles at the Surface	Number of Surface and Submerged Sea Turtles	Number of Hatchlings
Loggerhead	3.9	26.0	2.0
Leatherback	0.5	2.2	0.1
Kemp's ridley	0.2	0.7	0
Unidentified	0.4	2.2	N/A
Green	*	*	1.3
Total	**5**	**31**	**3.4**

Source: U.S. Marine Corps et al., 2003
ARG/MEU = Amphibious Ready Group/Marine Expeditionary Unit; N/A = not applicable
* Turtles listed as unidentified by GulfCet II are assumed to include green sea turtles

Table 6-7 indicates that the expected maximum number of sea turtles within the vessel transit area was less than 35. Realistically, effects from ARG/MEU operations that included, for example, vessel transit and troop movements were limited to turtles at the surface. Thus, less than nine turtles would occupy the surface of the transit area over the 10-day exercise. An additional potential effect to sea turtles was the possibility of surface vessels physically disturbing large *Sargassum* mats. These mats are considered likely habitat for juvenile turtles, as well as habitat for a number of fish species during various life stages. Large *Sargassum* mats, however, are distributed in a very patchy manner and are usually associated with ocean current convergence lines. Effects to *Sargassum* therefore were not considered likely (U.S. Marine Corps et al., 2003).

The USFWS issued a BO in 2003 in response to a BA submitted by the U.S. Navy and the U.S. Air Force. The USFWS anticipated incidental takes of the four species of sea turtles and the flatwoods salamander that occur on Eglin AFB and issued an ITS, pursuant to section 7 of the ESA. The ITS contains reasonable and prudent measures with implementing terms and conditions to help minimize takes.

NMFS issued a BO for the proposed MEU training on April 9, 2003. The BO states that the proposed air and land operations are not likely to adversely affect ESA-listed species under NOAA Fisheries purview, including sperm whales, Gulf sturgeon, and smalltooth sawfish. NOAA Fisheries further concluded that the proposed action's effects on designated Gulf sturgeon critical habitat are insignificant. Finally, NMFS concluded that the proposed ARG/MEU training is not likely to adversely affect species or critical habitat protected by the ESA, including loggerhead, green, and leatherback sea turtles.

The vessels transiting between the Navy ships and shore would introduce noise into the water, which could disturb protected species such as sea turtles or marine mammals. The noise characteristics (frequency, energy level, etc.) were not quantified, but were considered inconsequential when compared to the baseline level of noise produced by surface vessels in the Gulf of Mexico (U.S. Marine Corps et al., 2003).

The magnitude and intensity of vessels, materials, and troops moving to and from shore necessitated the closing of the operation area to commercial and recreational fishing. However, considering the small size of the exercise areas and the short time duration required for each landing activity, MEU training and operations were not expected to interfere with commercial and recreational fishing activities, and the effect was considered minimal (U.S. Marine Corps et al., 2003).

6.2.12.6.3 Eglin Gulf Test and Training Range Operations

Eglin AFB supported nearly 39,000 sorties during the timeframe of fiscal years (FY) 1995 through 1999 (U.S. Air Force, 2002). Most of the sorties were flown over the Gulf of Mexico, in the Eglin Gulf Test and Training Range (EGTTR). Mission activities conducted within the EGTTR can be summarized as Air Operations and Ordnance Testing and Training. Air Operations include all manned and unmanned aircraft flights through the EGTTR. Ordnance testing and training involves the release of expendables, which are defined as items that are deployed, released, or consumed (or potentially consumed) while performing an activity. Examples of expendables include bombs, missiles, bullets, chaff, flares, and other miscellaneous items.

Water quality may be negatively affected from the introduction of chemical materials from jet fuel, munitions, chaff, and flares. Fuel may be introduced into the water by the occasional downing of a target drone and by emergency in-flight fuel release (U.S. Air Force, 2002). Table 6-8 and Table 6-9 show the maximum amount of fuel deposited by these actions between 1995 and 2000. In reality, the amount is far less because the extreme volatility of the substance results in a significant amount (approximately 99 percent) of evaporation during descent. The remainder would disburse through the action of waves and currents.

Table 6-8. Estimated Volume of Fuel Released by Drones During EGTTR Missions

Drone Type	Quantity	Average Fuel Amount (gallons/drone)	Total Fuel Released (gallons)
QF-4	21	1,030	21,630
QF-106/4	35	735	25,725
BQM-34	20	40	800
MQM-107	23	30	690
		TOTAL	**48,845**

Source: U.S. Air Force, 2002

Table 6-9. Estimated Fuel Release from In-Flight Emergencies (IFE) During EGTTR Missions

Aircraft Type	IFE Sorties that Released Fuel	Average Released Fuel (gallons/sortie)	Total Fuel Released (gallons)	Fuel (gallons) Reaching Surface
F-15/F-15E	220	735	161700	1,620
F-18	4	735	2940	30
F-111	2	735	1470	20
F-117	0.2	735	150	2
AC/MC/C-130	0.5	1,470	700	10
		TOTAL	**166,960**	**1,682**

Source: U.S. Air Force, 2002

Chaff is primarily used as a defense mechanism and is released from engaged aircraft. Discharge of chaff results in the release of millions of aluminum dipoles (short fibers similar in appearance to human hair) that create an electromagnetic cloud around the aircraft, shrouding the plane from enemy radar and defense systems. The main chemical component of concern in chaff is aluminum. Due to the wide dispersion over large areas of the eastern Gulf of Mexico, chaff dispersion would vary for each of the water ranges (U.S. Air Force, 2002). A small portion of the chaff may dissolve over time. An assessment suggests that approximately 0.06 percent of the initial aluminum weight would dissolve in seawater. Although no criteria exist for aluminum in oceanic waters, it is a naturally occurring trace element (river input) in seawater and found at variable concentrations. Effects are therefore considered negligible (U.S. Air Force, 2002).

Flares are high-temperature heat sources that are ejected from aircraft to confuse and divert enemy heat-seeking or heat-sensitive missiles. Flares are also used to illuminate surface areas during nighttime operations. The principle chemical element of concern is magnesium. The total amounts of magnesium added to the Gulf of Mexico surface waters would be less than 0.0002 percent (Warning Area 151 [W-151] or Panama City OPAREA) and 0.0005 (W-470 or Pensacola OPAREA) percent of the background concentration (1.35 grams per liter [g/L] [11,266 lbs/gallon [gal]) of magnesium in the Gulf of Mexico surface waters. Due to this extremely small amount, no adverse effects are anticipated (U.S. Air Force, 2002).

Test and training missions conducted by Eglin AFB result in numerous flight activities in the EGTTR involving a variety of aircraft and missiles flying at a wide range of altitudes and traveling at speeds ranging from slow subsonic to supersonic. Subsonic and supersonic aircraft noise is basically continuous over the EGTTR while missions are in progress. Supersonic noise from EGTTR missions was determined to be not likely to adversely affect dolphins or other biological resources, or socioeconomic (human) resources (U.S. Air Force, 2002).

Underwater noise resulting from gunnery missions has been calculated. Noise results from 25-millimeter (mm), 40-mm, and/or 105-mm rounds being fired at the water surface. Various noise levels were found to be pertinent to effects to protected species. The distance from an exploding shell that these noise levels would reach was determined, and then the number of animals potentially affected was calculated. Generally, for the purposes of the EGTTR Programmatic Environmental Assessment (EA), noise levels above 205 decibels (dB) referenced to 1 micropascal squared second (dB re 1 μPa^2 s) are considered injurious, levels above 182 dB re 1 μPa^2 s are considered non-injurious harassment, and levels above 176 dB re 1 μPa^2 s are considered behavioral harassment. This 176 dB re 1 μPa^2 value was employed by the U.S. Air Force for behavioral takes of marine mammal species and was based on the *EA for the Use of the AN/SSQ-110A Sonobuoys in Deep Ocean Waters*. The harassment level is now set at 177 dB for all Air Force activities. Table 6-10 and Table 6-11 show the number of protected species potentially affected. All gunnery missions used in these calculations occur in W-151.

Table 6-10. Yearly Estimated Number of Marine Mammals Affected by the Gunnery Mission Noise

Species	Adjusted Density (No./km^2)	Level A Harassment Injurious 205 dB* EFD for Ear Rupture	Level B Harassment Non-Injurious 182 dB* EFD for TTS	Level B Harassment Non-Injurious 176 dB* EFD for Behavior
Bryde's whale	0.007	<0.001	0.010	0.041
Sperm whale	0.011	<0.001	0.016	0.064
Dwarf/pygmy sperm whale	0.024	<0.001	0.035	0.139
Cuvier's beaked whale	0.10	<0.001	0.015	0.058
Mesoplodon spp.	0.019	<0.001	0.028	0.110
Pygmy killer whale	0.030	<0.001	0.044	0.174
False killer whale	0.026	<0.001	0.038	0.151
Short-finned pilot whale	0.027	<0.001	0.039	0.157
Rough-toothed dolphin	0.028	<0.001	0.041	0.163
Bottlenose dolphin	0.810	0.006	1.177	4.706
Risso's dolphin	0.113	0.001	0.164	0.657
Atlantic spotted dolphin	0.677	0.005	0.984	3.934
Pantropical spotted dolphin	1.077	0.008	1.565	6.258
Striped dolphin	0.237	0.002	0.344	1.377
Spinner dolphin	0.915	0.007	1.330	5.316
Clymene dolphin	0.253	0.002	0.368	1.470
Unidentified dolphin**	0.053	<0.001	0.077	0.308
Unidentified whale	0.008	<0.001	0.012	0.046
All marine mammals	4.325	0.032	6.29	25.13

Source: U.S. Air Force, 2002
EFD = Energy Flux Density; km^2 = square kilometers; No. = number; TTS = temporary threshold shift
* dB = dB re 1 μPa^2 s
** Bottlenose dolphin/Atlantic spotted dolphin

Table 6-11. Yearly Estimated Number of Sea Turtles Affected by the Gunnery Mission Noise

Species	160 dB	170 dB	180 dB	190 dB	200 dB
Sea Turtles (number)	215	20.2	2.1	0.2	0.02

Source: U.S. Air Force, 2002
dB = decibels

Underwater noise may also affect non-protected resources such as fish. Impulsive noise at sufficient intensity is known to cause injury to the swim bladder and other air spaces inside fish. However, the intermittent nature of both the EGTTR missions (U.S. Air Force, 2002).

Direct physical effects to protected species and sensitive habitat (sea turtles, marine mammals, and *Sargassum* mats) may occur when the surface of the water is physically struck by gunnery ordnance or other falling objects. The BO issued by NMFS estimated that one sperm whale and four sea turtles would be potentially affected (physically struck or startled) by falling objects (U.S. Air Force, 2002). The BO issued by NMFS estimates one sperm whale and four sea turtles. Eglin AFB has also requested a renewal for authorization to take up to 271 marine mammals by harassment incidental to conducting air-to-surface gunnery missions in the Gulf of Mexico.

The large number of sorties flown over the EGTTR over the course of a year requires dedicated management of military and commercial airspace. However, these activities have been occurring for years, and control of the airspace is well established. Therefore, no additional effects are anticipated (U.S. Air Force, 2002).

6.2.12.6.4 Cape San Blas Activities

Eglin AFB maintains property on Cape San Blas (CSB), Florida. Air Force facilities on CSB indirectly support nearly all air operations within the EGTTR warning area W-151 (Panama City OPAREA), as well as some of the air operations in W-470. Additionally, CSB facilities directly support some air missions (5,415 during FY 1994 through FY 1997), including surface-to-air missile launches. Up to 26 surface-to-air missiles were launched per year (4 Patriot, 16 Caesar Trumpet, and 6 Viper). Some smaller, portable missiles were also fired at QF-4 drones, with up to two drones potentially downed in the Gulf of Mexico per year. In addition, CSB supports limited surf zone testing and training activities in the nearshore shallow waters. Although no specific test or training missions have been identified, typical activities included underwater navigation and reconnaissance missions, as well as small inert munitions activities performed by the Navy Explosive Ordnance Disposal training school (U.S. Air Force, 1999).

CSB activities include effects to air quality, water quality, protected species and sensitive habitats, airspace management, and effects due to noise. The CSB Programmatic EA identified issues associated with restricted access, noise, habitat alteration, expended materials, electromagnetic radiation, chemical materials, and direct physical effects (U.S. Air Force, 1999).

For the purpose of public safety and the security of test and training operations, use of land and water areas and airspace beyond Air Force property boundaries have been occasionally and briefly restricted for some surface-to-air missile activities. Water access has been restricted for approximately 69 hours per year (U.S. Air Force, 1999).

Expended materials from CSB missions resulted primarily from the surface-to-air missile launch missions. Missile components and drones from missile tests typically consisted of aluminum and steel housing assemblies, optical sensors, guidance and control electronics, radio transmitters and receivers, and a power supply that may include lithium or nickel-cadmium batteries. Although most typical missions have not planned for the intentional downing of drones, surface-to-air missiles and drone targets that potentially fall on land have relatively benign environmental effects. Expended materials falling into nearshore waters had the potential to physically strike a boat, person, marine animal, or other receptor at the surface. Calculations predict, however, that the likelihood is remote (U.S. Air Force, 1999).

The introduction of chemical materials into the CSB environment occurred primarily from missile and rocket exhaust emissions as a result of the surface-to-air missile launch activities. The amount of chemical materials released into the air and water is summarized in Table 6-12.

Table 6-12. Chemical Materials Associated With Missile Launch Activities

Environmental Receptor	Chemical Material	Maximum Exposure (mg/m^3)
Air	Al_2O_3 (alumina)	0.021
	CO (carbon monoxide)	39.11
	HCl (hydrochloric acid)	0.012
	NO_x (nitrogen oxides)	0.009
Water	JP-8 Fuel (Jet Propulsion fuel, type 8)	0.023

Source: U.S. Air Force, 1999
mg/m^3 = milligrams per cubic meter

The number of aircraft and missile flights in the CSB vicinity required management of military and commercial airspace. However, these activities fell well within the management capabilities of airspace controllers (U.S. Air Force, 1999).

6.2.12.6.5 Santa Rosa Island Activities

Eglin AFB controls 19,263,244 square meters (m^2) (19.3 km^2 or 7.4 mi^2) of Santa Rosa Island (SRI), which includes 15 Air Force test sites. In addition to the SRI land mass, the surf zone is also considered part of the zone of effect. The surf zone is a shallow area covering the continental shelf seaward of SRI to a distance of approximately 14.5 km (7.8 NM). The distance from the SRI shoreline that corresponds to this depth varies from approximately 0.8 km (0.4 NM) at the western side of the Air Force property to 2.4 km (1.3 NM) at the eastern side (U.S. Air Force, 2005a). Several activities conducted on SRI and in the surf zone have the potential to affect the resources analyzed in Chapter 4.

Electronic Countermeasures (ECM) and Electronic Systems Testing is conducted in the vicinity of SRI (U.S. Air Force, 2005a). Training is routinely done aircraft-against-aircraft or aircraft-against-ground/surface ship systems. Any part of the Eglin Range Complex can be used for this type of training, but it is mostly done over the water. Surface-to-air missile tests launch missiles from a variety of locations, including A-15 on SRI and surface vessels, at target aircraft in the EGTTR. A variety of surf zone testing/training activities may occur as needed and include mine clearance testing and explosive ordnance disposal training (U.S. Air Force, 2005a).

Although the number of missile and aircraft flights is not quantified, air pollutant emission is a potential effect issue, as is airspace management. Air sorties associated with SRI lack the intensity and frequency of those associated with other activities, and the effects are considered minimal (U.S. Air Force, 2005a).

If increased use of the surf zone occurs, the potential for effects to geology, water quality, cultural resources, marine life, and protected species and habitats exist (U.S. Air Force, 2005a). Mine clearance and ordnance disposal could result in underwater detonations on or close to the sediment. This could cause turbidity and damage to essential fish habitat (EFH) (such as natural or artificial reefs) and cultural resources. Turbidity would be very brief and localized, as wave and current action would disperse the sediments (U.S. Air Force, 2005a). Environmental regulations would require that such training not be undertaken in the vicinity of cultural resources, EFH, or other sensitive habitats. A small amount of chemical materials would be added to the water column, but would be diluted to the point of insignificance (U.S. Air Force, 2005a). Detonations could cause injury to protected species such as sea turtles and marine mammals, and to non-protected resources such as fish. However, surveys for the presence of protected species would be required before such activities. Therefore, effects are considered unlikely (U.S. Air Force, 2005a).

6.2.12.6.6 Precision Strike Weapons Test

The U.S. Air Force Air Armament Center (AAC) and the U.S. Navy, in cooperation with the 46th Test Wing Precision Strike Division (46 OG/OGMTP), proposes to conduct a series of Precision Strike Weapons (PSW) test missions during the next five years utilizing resources within the Eglin Military Complex, including two sites in the EGTTR (U.S. Air Force, 2005b). The weapons to be tested are the Joint Air-to-Surface Stand-off Missile (JASSM) AGM-158 A and B, and the small-diameter bomb (SDB) GBU-39/B. The JASSM is a precision cruise missile designed for launch from outside area defenses to kill hard, medium-hardened, soft, and area type targets. The SDB weapon is a 113-kg (250-lb) class, air-to-surface, precision-guided munition. As many as two live and four inert JASSM missiles per year would be launched from an aircraft above the Gulf of Mexico at a target located approximately 28 to 44 km (15 to 28 NM) offshore of Eglin AFB (U.S. Air Force, 2005b). Detonation of the JASSM would occur under one of three scenarios:

- Detonation upon impact with the target, about 1.5 m (5 ft) above the Gulf of Mexico surface.
- Detonation upon impact with a barge target at the surface of the Gulf of Mexico.
- Detonation at 120 milliseconds (msec) after contact with the surface of the Gulf of Mexico.

In addition to the JASSM explosive, as many as six live and 12 inert SDBs per year would also be dropped on the target. Targets would be located in less than 61 m (200 ft) of water and more than 22 km (12 NM) offshore (U.S. Air Force, 2005b). Detonation of the SDBs would occur under one of two scenarios:

- Detonation of one or two bombs upon impact with the target, about 1.5 m (5 ft) above the Gulf of Mexico surface.
- Height of burst test: Detonation of one or two bombs 3 to 8 m (about 10 to 26 ft) above the Gulf of Mexico surface.

Activities associated with PSW testing may potentially affect water quality, biological resources, and the anthropogenic (man-made) environment (U.S. Air Force, 2005b). Chemical products may be released into the aquatic environment during explosive detonations. The detonation of explosives usually results in the complete combustion of the original material and the emission of carbon dioxide, carbon, carbon monoxide, water, and nitrogen compounds. Residual chemical products are usually extremely dilute and are dispersed within hours by wave and current action. Although data is lacking, these compounds are not expected to persist in the marine environment, and there is expected to be no effects to sea turtles, marine mammals, or the marine environment in general (U.S. Air Force, 2005b). During the time of operations, a safety zone on the surrounding water surface would be closed to commercial and recreational fishing. However, the total closed area compared to other areas available in the Gulf of Mexico is insignificant. In addition, the closures would be infrequent (U.S. Air Force, 2005b).

Exploding JASSM and SDB bombs will result in both pressure waves and noise in the marine environment (U.S. Air Force, 2005b). Detonations would have the potential for effects to protected and non-protected marine species, including sea turtles, marine mammals, and fish. As stated before, injury can result from the shock wave interacting with air spaces in an animal's body, such as swim bladders, the inner ear, and viscera. At further distances from the detonation, noise may cause hearing impairment or behavioral modification in individuals. The BO by NMFS (2005) related to PSW activities included calculations of sea turtles potentially affected before and after mitigation measures. After the implementation of the required measures, a total of 12 sea turtles may be affected (lethally and non-lethally) over a five-year period (NMFS, 2005c). The number of marine mammals potentially affected as estimated by Eglin AFB is summarized in Table 6-13 and Table 6-14. NMFS has approved an incidental take permit for Air Force/Navy activities to allow for 1 mortality, 2 injury, and 53 harassment takes of marine mammals) (NMFS, 2006k).

Table 6-13. Marine Mammal Densities and Risk Estimates for Level A Harassment (205 dB EFD 1/3-Octave Band) Noise Exposure During PSW Missions

Species	Density	Number of Animals Exposed from 1-ft Depth Detonations	Number of Animals Exposed from >20-ft Depth Detonations
Summer			
Dwarf/pygmy sperm whale	0.013	0.0024	0.0247
Bottlenose dolphin	0.81	0.1491	1.5417
Atlantic spotted dolphin	0.677	0.1246	1.2886
T. truncatus/S. frontalis	0.053	0.0098	0.1009
TOTAL		**0.29**	**3.0**
Winter			
Dwarf/pygmy sperm whale	0.013	0.0024	0.0285
Bottlenose dolphin	0.81	0.1491	1.7737
Atlantic spotted dolphin	0.677	0.1246	1.4824
T. truncatus/S. frontalis	0.053	0.0098	0.1161
TOTAL		**0.29**	**3.4**

Source: U.S. Air Force, 2005b
dB = decibels; EFD = Energy Flux Density; ft = feet; PSW = Precision Strike Weapon

Table 6-14. Marine Mammal Densities and Risk Estimates for Level B Harassment (182 dB EFD 1/3-Octave Band) Noise Exposure During PSW Activities

Species	Density	Number of Animals Exposed from 1-ft Depth Detonations	Number of Animals Exposed from >20-ft Depth Detonations
Summer			
Dwarf/pygmy sperm whale	0.013	0.0226	0.5070
Bottlenose dolphin	0.81	1.4089	31.5886
Atlantic spotted dolphin	0.677	1.1776	26.3735
T. truncatus/S. frontalis	0.053	0.0922	2.0669
TOTAL		**2.7**	**60.5**
Winter			
Dwarf/pygmy sperm whale	0.013	0.0280	0.8633
Bottlenose dolphin	0.81	1.7448	53.7906
Atlantic spotted dolphin	0.677	1.4583	44.9300
T. truncatus/S. frontalis	0.053	0.1142	3.5196
TOTAL		**3.3**	**103.1**

Source: U.S. Air Force, 2005b
dB = decibels; EFD = Energy Flux Density; ft = feet; PSW = Precision Strike Weapons

6.2.12.6.7 Naval Surface Warfare Center Panama City Division

In April 2008, the Navy released the Draft EIS/OEIS for Naval Surface Warfare Center (NSWC) Panama City Division (PCD) Mission Activities (DON, 2008j). NSWC PCD is the U.S. Navy's premier research and development organization focused on littoral (coastal region) warfare and expeditionary (designed for military operations abroad) warfare. NSWC PCD provides RDT&E and support for expeditionary warfare, operations in extreme environments, MIW, maritime operations, and coastal operations. Littoral and expeditionary warfare operations are conducted in a natural operating environment with direct access to the Gulf of Mexico, St. Andrew Bay, and associated coastal regions. The Gulf of Mexico provides an environment that can substitute for many of the littoral areas in the world for current and future Navy operations. The NSWC PCD operations occur in W-151, W-155, W-470, and St. Andrew Bay. The EIS/OEIS evaluates the effects associated with the littoral and expeditionary warfare activities proposed for the For the purposes of this chapter, the No Action Alternative represents both past and present naval operations in the GOMEX OPAREA.

RDT&E activities involve a variety of naval assets, including ships, aircraft, and underwater systems that support eight primary test capabilities: air, surface, and subsurface operations; sonar, electromagnetic, laser, and ordnance operations; and projectile firing occurring within or over the water environment up to the average high tide mark. The vast majority of the tests are conducted using inert/non-explosive mine substitutes, though occasionally testing requires actual mine detonation in real-world circumstances. A brief overview of the eight RDT&E operations is provided in the following paragraphs.

Air operations conducted by NSWC PCD to support the RDT&E activities mainly utilize helicopters (MH-53, MH-60, UH-1, and variants). Five types of RDT&E activities that are conducted from aircraft at NSWC PCD include (1) support activities for clearance and monitoring, (2) tows of an object that contains active or passive sensors towed in the water column (the water between the surface and the sea floor), (3) captive carriage to test the handling of aircraft during transport, separation, and release of objects, and (4) aerial separation of objects that would not be retrieved, to test inert objects, rockets, and/or mines and the aircraft's flight effects on deployment of such items. The fifth activity includes the only form of live aerial expendables, which includes gun firing at predetermined targets from a helicopter.

Surface operations for NSWC PCD RDT&E includes: support activities, tows (a type of test), deployment and recovery unmanned underwater vehicles (UUV), sonobuoys, targets, and other test systems, and the testing of new, alternative, or upgraded hydrodynamics and propulsion, navigational, and communication systems.

Subsurface operations activities include diving, salvage, robotic vehicles, UUVs, and mooring and burying of mines. NSWC PCD also develops, upgrades, and manages new underwater mine systems. Tests are required to collect data and information to analyze functionality of the various systems developed at NSWC PCD. Other MIW testing conducted at NSWC PCD requires the placement of temporary minefields at varying depths (surf zone to 183 m [600 ft]) at NSWC PCD. These temporary target fields consist of inert mines, mine-like objects (MLO), and versatile exercise mines (VEMs), which are used to simulate bottom and moored mine threats.

Sonar operations at NSWC PCD involve the testing of various sonar systems in the ocean and the laboratory to demonstrate the systems' capability to detect, locate, and characterize MLOs under various environmental conditions. These activities include sonars that range in frequency from 1 kilohertz (kHz) to 3 megahertz (MHz) and are typically mounted on a towed body or other underwater moving platform.

Electromagnetic operations at NSWC PCD consist of the development and testing of an array of magnetic sensors that generate electromagnetic fields used in mine countermeasures (MCM) operations.

Laser operations include underwater mine identification and air-to-water mine identification. Laser operations are typically conducted from aircraft, but ship-based tests are also conducted.

Ordnance operations and **projectile firing** make up the final two operations conducted at NSWC PCD. NSWC PCD leads the development of naval airborne, surface, organic, and shallow water MCM systems. Real-life test scenarios that involve live explosives are required to demonstrate the capability and effectiveness of the systems developed and tested at NSWC PCD. Live testing is only conducted after a system has successfully completed inert testing and an adequate amount of data has been collected to support the decision for live testing. These tests require that live mines be closely monitored and that the minimum number of live munitions necessary to meet the testing requirement be used. Live testing may occur from the surf zone out to the outer perimeter of NSWC PCD. Gunfire might be used during test missions, including 5-in, 20-mm, 25-mm, 30-mm, 40-mm, 76-mm, and various small arms ammunition. Projectiles associated with these rounds are mainly armor-piercing projectiles. The 5-inch round is a high-explosive projectile containing approximately 3.63 kg (8 lbs) of explosive material.

Physical (geology and sediments, in-air sound, and water quality), biological (marine habitats, invertebrates, fish, EFH, birds, marine mammals, and sea turtles), and man-made resources (airspace management, artificial reefs, environmental justice and risks to children, and cultural resources) were analyzed to determine the potential effects any expended materials would cause. It was determined that there will be no significant impact and no significant harm to these resources under the No Action Alternative (DON, 2008j).

Acoustic analysis was performed to determine potential effects to marine mammals from sonar, ordnance, and projectile firing operations under the No Action Alternative. In addition, acoustic analysis was performed to determine potential effects to sea turtles from ordnance and projectile firing operations (DON, 2008j). Refer to Chapter 4 of the NSWC PCD Draft EIS/OEIS for a discussion of the methodology used to measure these effects. Acoustic analysis indicates that 746 marine mammals may be exposed to levels of sound likely to result in Level B harassment during sonar operations. No threatened or endangered species will be exposed to sound likely to result in harassment during sonar operations. In addition, no marine mammals will be exposed to levels of sound likely to result in harassment during ordnance and projectile firing operations. The results also indicate the quantity of ESA-listed sea turtles that may be exposed to levels of sound; a total of three turtles may result in Level B harassment during ordnance operations. No sea turtles will be exposed to sound likely to result in harassment during projectile firing operations (DON, 2008j).

6.2.12.7 Military Operations – Western Gulf of Mexico

6.2.12.7.1 NAS Corpus Christi

NAS Corpus Christi covers an offshore operating area of 23,583.3 km^2 (6,867 NM^2) off the coast of Texas and is considered part of the GOMEX Range Complex. Most of the activities that will be taking place in the area only include Mine Countermeasures, Mine Neutralization and GUNEX operations, which have been further discussed in Section 6.2.12.7. The Navy does not expect any increase in activities taking place in the Corpus Christi Area.

6.3 REASONABLY FORESEEABLE FUTURE ACTIONS RELEVANT TO THE PROPOSED ACTION

6.3.1 Military Operations

6.3.1.1 Atlantic Ocean, Offshore of the Southeastern United States

6.3.1.1.1 VACAPES Range Complex

As stated in Section 6.2.12.4.1, the VACAPES Range Complex Draft EIS/OEIS was released in June 2008. In that Draft EIS/OEIS, the Navy's preferred alternative was identified as Alternative 2, Increases and Modifications in Operational Training, Accommodate Force Structure Changes, and Implement Enhancements. The Navy's preferred alternative is considered representative of its future actions within the VACAPES Range Complex. The Final EIS/OEIS is expected to be released to the public in 2009; refer to this document for all cumulative impacts (DON, 2008d).

Under Alternative 2, the Navy proposes to increase or modify training and RDT&E operations from current levels in support of the FRTP, accommodate mission requirements associated with force structure changes, including those resulting from the introduction of new platforms (aircraft and weapons systems), and implement enhanced range complex capabilities in the VACAPES Range Complex. Alternative 2 would implement enhancements to the minimal extent possible to meet the components of the FRTP to implement the FRP. It would also increase operational training, expand warfare missions, and accommodate force structure changes, which would include changing weapon systems and platforms, and homebasing new aircraft and ships, as well as additional mine warfare training capabilities, the establishment of MIW training areas with small fields of mine shapes, and implementation of additional enhancements to enable the range complex to meet future requirements (DON, 2008d). (Mine detection sonar will be used and use of this sonar is covered under this AFAST EIS/OEIS.)

The Navy's goal with Alternative 2 is to reduce the number of BOMBEX training events that involve dropping live, high-explosive ordnance on targets at-sea in comparison to the No Action Alternative, which depicts current operations and activities (DON, 2008d).

Physical, biological, environmental, cultural, socioeconomic, and human resources were analyzed to determine the potential effects any expended materials would cause. It was determined that there will be no significant impact and no significant harm to physical, biological, environmental, cultural, socioeconomic or human resources due to the training activities occurring in the VACAPES Range Complex under Alternative 2 (DON, 2008d).

Acoustic analysis was performed to determine potential effects to marine mammals and sea turtles in response to Alternative 2. Refer to Chapter 3 of the VACAPES Range Complex EIS/OEIS for a discussion of the methodology used to measure these effects. Acoustic analysis indicates that 3,752 total marine mammals (including ESA-listed species) may be exposed to levels of sound likely to result in Level B harassment. Acoustic analysis also indicates that 36 total marine mammals (including ESA-listed species) may be exposed to levels of sound likely to result in Level A harassment. The analysis also indicates that the effect to 1 marine mammal mortalities may also result. The results of the acoustic analysis indicates the quantity of ESA-listed marine mammal species that may be exposed to levels of sound, 10 ESA-listed species may be exposed to levels of sound likely to result in Level B harassment. The results also indicate the quantity of ESA-listed sea turtles that may be exposed to levels of sound, 1,181 species may result in Level B harassment, 11 may result in Level A harassment, and none will result in mortality. The exposure estimates for each alternative represents the total number of exposures and not necessarily the number of individuals exposed, as a single individual may be exposed multiple times over the course of a year (DON, 2008d). In addition, these exposure estimates do not include the incorporation of mitigation measures, which are designed to reduce exposure of marine mammals to potential impacts in an effort to achieve the least practicable adverse effect on marine mammal species or populations.

6.3.1.1.2 CHPT Range Complex

As stated in Section 6.2.12.4.2, the CHPT Range Complex Draft EIS/OEIS was released in August 2008. In that Draft EIS/OEIS, the Navy's preferred alternative was identified as Alternative 2, Eliminate High Explosive Bombs At-sea and Implement Enhanced Mine Warfare Training Capabilities. The Navy's preferred alternative is considered representative of its future actions within the Cherry Point Range Complex. The Final EIS/OEIS is expected to be released to the public in 2009; refer to this document for all cumulative impacts (DON, 2008f).

Under Alternative 2, the Navy will continue conducting current activities as well as increasing range complex operations and capabilities enhancement to address Navy and DoD emerging and foreseeable future training and RDT&E requirements. Other than the continuation of current training and testing activities, the preferred alternative also allows for an across-the-board increase in most operations to provide the Navy and Marine Corps with flexibility to train for real world situations, plus change in type and quantity of operations and tactical employment of forces to accommodate expanded mission areas, force structure changes, and new range capabilities. Alternative 2 would also eliminate all high explosive (HE) bombing exercises at-sea (BOMBEX Air-to-Surface) and designate two mine warfare (MIW) training areas for major exercise MIW events. (Mine detection sonar will be used and use of this sonar is covered under this AFAST EIS/OEIS.) With the elimination of HE BOMBEX, the Navy and Marine Corps plans to continue to drop Non-Explosive Practice Munitions (NEPM or inert bombs) (DON, 2008f).

Furthermore, the Navy intends to perform mine neutralization operations for both ESG and CSG major exercises in the area currently designated for underwater detonation (UNDET) training, 5.6 to 22.2 km (3 to 12 NM) off the coast in the Cherry Point OPAREA (DON, 2008f).

Physical, biological, environmental, cultural, socioeconomic, and human resources were analyzed to determine the potential effects any expended materials would cause. It was determined that there will be no significant impact and no significant harm to physical, biological, environmental, cultural, socioeconomic or human resources due to the training activities occurring in the Cherry Point Range Complex (DON, 2008f).

Acoustic analysis was performed to determine potential effects to marine mammals and sea turtles as a result of the activities being performed by the Preferred Alterative. Refer to Chapter 3 of the Navy Cherry Point Range Complex Draft EIS/OEIS for a discussion of the methodology used to measure these effects. Acoustic analysis indicates that 3 total marine mammals (including ESA-listed species) may be exposed to levels of sound likely to result in Level B harassment. No mortalities are predicted due to active sonar activities. The results of the acoustic analysis indicates that no ESA-listed marine mammal species will may be exposed to levels of sound resulting in any level of harassment. The results also indicate that no ESA-listed sea turtles will be exposed to levels of sound likely to result in any level of harassment. The exposure estimates for each alternative represents the total number of exposures and not necessarily the number of individuals exposed, as a single individual may be exposed multiple times over the course of a year (DON, 2008f). In addition, these exposure estimates do not include the incorporation of mitigation measures, which are designed to reduce exposure of marine mammals to potential impacts in an effort to achieve the least practicable adverse effect on marine mammal species or populations.

6.3.1.1.3 JAX Range Complex

As stated in Section 6.2.12.4.3, the JAX Range Complex Draft EIS/OEIS was released in June 2008. In that Draft EIS/OEIS, the Navy's preferred alternative was identified as Alternative 2, Increases and Modifications in Operational Training, Accommodate Force Structure Changes, and Implement Enhancements Mine Warfare Training Capability. The Navy's preferred alternative is considered representative of its future actions within the JAX Range Complex. The Final EIS/OEIS is expected to be released to the public in 2009; refer to this document for all cumulative impacts (DON, 2008e).

The proposed action's purpose is to: achieve and maintain Fleet readiness using the JAX Range Complex to support and conduct current, emerging, and future training operations and RDT&E operations; expand warfare missions supported by the JAX Range Complex; and upgrade and modernize existing range capabilities to enhance and sustain Navy training and RDT&E. Also, the proposed action is needed to provide range capabilities for training and equipping combat-capable naval forces ready to deploy worldwide (DON, 2008e).

Under Alternative 2, the Navy intends to increase or modify training and RDT&E operations from current levels as necessary in support of the FRTP, accommodate mission requirements associated with force structure changes, including those resulting form the introduction of new platforms (aircraft and weapons systems), and implement enhanced range complex capabilities in the JAX Range Complex. Alternative 2 would increase operational training, expand warfare missions, accommodate force structure changes (including changing weapon systems and platforms and homebasing new aircraft and ships), and implementing enhancements, to the minimal extent possible to meet the components of the proposed action. This alternative is composed of all currently conducted operations including the introduction of the new MH-60 helicopter and new organic mine countermeasure systems. Additional mine warfare training capabilities and implementation of additional enhancements to enable the range complex to meet future requirements can also be expected of Alternative 2 (DON, 2008e).

With the preferred alternative, the Navy expects to eliminate live bombing exercises (BOMBEX) and designate MIW Training Areas in the JAX/CHASN OPAREA for enhanced mine countermeasures and neutralization training during major exercises (DON, 2008e). (Mine detection sonar will be used and use of this sonar is covered under this AFAST EIS/OEIS.)

Physical, biological, environmental, cultural, socioeconomic, and human resources were analyzed to determine the potential effects any expended materials would cause. It was determined that there will be no significant impact and no significant harm to physical, biological, environmental, cultural, socioeconomic or human resources due to the training activities occurring in the JAX/CHASN Range Complex under Alternative 2 (DON, 2008e).

Acoustic analysis was performed to determine potential effects to marine mammals and sea turtles as a result of activities performed with Alternative 2. Refer to Chapter 3 of the Jacksonville Range Complex EIS/OEIS for a discussion of the methodology used to measure these effects. Acoustic analysis indicates that 79 total marine mammals (including ESA-listed species) may be exposed to levels of sound likely to result in Level B harassment. Acoustic analysis also indicates that 2 total marine mammals (including ESA-listed species) may be exposed to levels of sound likely to result in Level A harassment. The results of the acoustic analysis indicate that no ESA-listed marine mammal species are expected to be exposed to levels of sound which will result in some sort of harassment. No mortalities are predicted due to the active sonar activities. The results also indicate the quantity of ESA-listed sea turtles that may be exposed to levels of sound, 36 species may result in Level B harassment. The exposure estimates for each alternative represents the total number of exposures and not necessarily the number of individuals exposed, as a single individual may be exposed multiple times over the course of a year (DON, 2008e). In addition, these exposure estimates do not include the incorporation of mitigation measures, which are designed to reduce exposure of marine mammals to potential impacts in an effort to achieve the least practicable adverse effect on marine mammal species or populations.

6.3.1.1.4 Homeporting of Additional Surface Ships at Naval Station Mayport, Florida

The Navy released a Draft EIS in March 2008 to evaluate the potential environmental effects associated with the homeporting of additional U.S. Fleet Forces surface ships at Naval Station Mayport. Naval Station Mayport is located in northern Florida east of Jacksonville along the St. Johns River and the Atlantic Ocean. Naval Station Mayport maintains and operates facilities which provide support to the operations of deploying Navy ships, aviation units, and staff, both home based and transient. Naval Station Mayport also provides logistic support for operating forces, dependent activities, and other commands as assigned (DON, 2008l).

The types of ships to be addressed in the EIS include those types currently homeported at Naval Station Mayport: cruisers (CGs), destroyers (DDGs), and frigates (FFGs), as well as additional types of ships identified by CNO, including amphibious assault ships (LHDs), amphibious transport dock ships (LPDs), dock landing ships (LSDs), and a CVN. The type and number of ships included in each alternative were either specified by CNO or defined by fleet type commanders. The number of additional ships proposed for each alternative is in addition to the ships currently homeported at Naval Station Mayport. The alternatives considered in this EIS could be implemented between the years of 2009 and 2014, depending upon deployment schedules of ships or construction schedules for facilities associated with each alternative. As such, the year 2014 represents the end state, or the year by which all alternatives could be completely implemented (DON, 2008l).

The Navy's EIS reviewed and assessed 12 action alternatives and the No Action alternative:

- Cruiser/Destroyer (CRU/DES) homeporting (Alternative 1)
- LHD homeporting (Alternative 2)
- Nuclear Powered Aircraft Carrier (CVN) capable (Alternative 3)
- CVN homeporting (Alternative 4)
- Amphibious Ready Group (ARG) homeporting (Alternative 5)
- Seven different combinations of the first four alternatives (Alternatives 6 – 12)
- No Action Alternative

At present, the Navy has not identified a preferred alternative.

Depending on the alternative selected, the proposed action may include:

- Maintenance facilities improvements
- Utilities upgrades
- Personnel support improvements
- Wharf improvements
- Parking facilities and traffic improvements
- Construction of CVN nuclear propulsion plant maintenance facilities
- Dredging and disposal of dredged material

Potential environmental effects to earth resources, land and offshore use, water resources, air quality, noise, biological resources, cultural resources, traffic, socioeconomics, general services, utilities, and environmental health and safety were analyzed. Of those, potential environmental effects to biological resources are relevant to this EIS/OEIS.

Group 1 alternatives (Alternatives 1, 2, 5, and 6) would have no impacts to marine communities, marine fish, EFH, federally threatened or endangered species, or marine mammals.

With the proposed dredging under all Group 2 (Alternatives 3, 7, 9, and 11) and 3 (Alternatives 4, 8, 10, and 12) alternatives, there would be short-term minor impacts from dredging activities to marine resources, including marine flora, invertebrates, and fish in the vicinity of the dredging areas and the ocean dredged material disposal site.

Potential effects to marine mammals (i.e., coastal bottlenose dolphin, which are common in the dredge area) may result from dredge activities associated with all Group 2 and 3 alternatives. Although dolphins are sensitive to noise in some of the frequencies that would be generated from dredge activities, they are highly mobile and would only be anticipated in the vicinity of dredge operations for short periods of time. No injury or mortality of any marine mammal species is reasonably foreseeable.

Under all Group 3 alternatives, in-water construction activities associated with the installation of the Type III heavy weather moorings at Wharf F would require approximately one hour of pile driving that could result in additional impacts to marine mammals. However, mitigation is proposed to include use of a vibratory hammer for pile driving if at all practicable and ceasing operations when a marine mammal is observed within 15 m (50 ft) of the proposed pile driving operations and until the animal leaves the area (this is an extension of this element of USACE's *Special Manatee Protection Conditions* to all marine mammals). Therefore, there would be no injury or mortality of any marine mammal species (DON, 2008l).

There would be no impact to biological resources under the No Action alternative (DON, 2008l).

6.3.1.1.5 Undersea Warfare Training Range

The Navy released a Draft EIS/OEIS in fall 2008 to evaluate the potential environmental effects associated with the construction and operations of an underwater instrumented range off the Southeastern U.S. Coast (DON, 2008k). A revised Notice of Intent to prepare the EIS/OEIS and a thirty day scoping period was published in the Federal Register on September 21, 2007. Four public meetings were held during the months of September and October 2008, and comments were received from September 12, 2008 to October 27, 2008. The Draft EIS/OEIS is incorporated by reference and is available for downloading/viewing via the internet at the following website address: (http://projects.earthtech.com/uswtr/USWTR_index.htm). The proposed action is to place undersea cables and transducer nodes in a 1,713 km^2 (500 NM^2) area of the ocean to create an undersea warfare training range (USWTR) for use as an ASW training range. The ASW training would involve up to three vessels and two aircraft using the range for any one training event, although events would typically involve fewer units. The instrumented area would be connected to the shore via a single trunk cable. The proposed action would require logistical support for ASW training, including the handling (launch and recovery) of exercise torpedoes (non-explosive) and submarine target simulators (DON, 2008k). The purpose of the proposed action is to enable the Navy to train effectively in a shallow water environment at a suitable location for Atlantic Fleet ASW capable units. The 37- to 274-m (120- to 900-ft) depth parameter for the range was derived from collectively assessing depth requirements of the platforms that would be using this range, and approximate the water depth of potential areas of conflict that the Navy has identified.

The Navy analyzed potential environmental impacts at the following four sites:

- Site A – offshore of northeastern Florida (JAX OPAREA).
- Site B – offshore of central South Carolina (CHASN OPAREA).
- Site C – offshore of southeastern North Carolina (CHPT OPAREA).
- Site D – offshore of northeastern Virginia (VACAPES OPAREA).

The Preferred Alternative has been determined to be Site A. Potential effects to physical, ecological, and socioeconomic resources were analyzed in the USWTR OEIS/EIS. With the exception of EFH, it was determined there would be no significant impact to physical, ecological (non acoustic effects only), or socioeconomic resources. Cable installation may have a temporary impact on benthic organisms, including benthic fish, during the placement of the transducer nodes and interconnect cable and the burial of the trunk cable. As this action would result in a reduction of the quantity and/or quality of some types of EFH, installation of the proposed USWTR may adversely affect EFH at all of the four proposed sites (DON, 2008k).

Acoustic analysis was performed to determine potential effects to marine mammals from sonar operations. Refer to Chapter 4 of the USWTR OEIS/EIS for a discussion of the methodology used to measure these effects. Acoustic analysis indicates that 108,108 marine mammals may be exposed to levels of sound likely to result in Level B harassment during sonar operations at the preferred alternative site. In addition, up to four marine mammals may be exposed to levels of sound likely to result in Level A harassment. Of these marine mammals, no threatened or endangered marine mammals will be exposed to levels of sound likely to result in Level A harassment, and 156 will be exposed to levels of sound likely to result in Level B harassment (DON, 2008k). Based on the acoustic screening analysis, plankton, invertebrates, seabirds, sea turtles, pinnipeds, and manatees were excluded from acoustic effect analysis (DON, 2008k).

6.3.1.2 Surveillance Towed Array Sensor System Low Frequency Active Sonar

The Final Supplemental Environmental Impact Statement (SEIS) for Surveillance Towed Array Sensor System Low Frequency Active (SURTASS LFA) Sonar was issued in April 2007, and the Record of Decision (ROD) was issued in August 2007 (DON, 2007; 2007h). Under the action, a maximum of four systems would be deployed in the Pacific-Indian ocean area and in the Atlantic-Mediterranean area. Of an estimated maximum 294 underway days per year, the SURTASS LFA sonar would be operated in the active mode about 240 days. During these 240 days, active transmissions would occur for a maximum of 432 hours per year per vessel. The duty cycle of the SURTASS LFA sonar would be limited (it would generally be on between 7.5 and 20 percent of the time [7.5 percent is based on historical LFA operations since 2003 and the physical maximum limit is 20 percent]). The LFA transmitters would be off the remaining 80 to 92.5 percent of the time (DON, 2007). The decision, as stated in the ROD, implemented Alternative 2 as the Preferred Alternative (DON, 2007h).

Under Alternative 2, the SURTASS LFA sonar would be employed with geographical and seasonal restrictions to include maintaining sound pressure level below 180 dB within 22 km (12 NM) of any coastline and within the offshore biologically important areas that are outside of 22 km (12 NM). During the annual LOA process, the Navy will evaluate potential offshore biologically important areas within the proposed operating areas for each ship and incorporate restrictions, as required, into the LOA applications for NMFS's review and action. LFA sound fields will not exceed 145 dB within known recreational and commercial dive sites. Monitoring mitigation includes visual, passive acoustic, and active acoustic (high-frequency marine mammal monitoring [HF/M3] sonar) to prevent injury to marine animals when employing SURTASS LFA sonar by providing methods to detect these animals within the 180 dB LFA mitigation zone (DON, 2007).

The Final SEIS analyzed potential impacts to fish, sea turtles, marine mammals, and socioeconomics (commercial and recreational fishing, research and exploration activities, other recreational activities). Under Alternative 2, the potential impact on any stock of fish, sharks or sea turtles from injury was considered negligible, and the effect on the stock of any fish, sharks or sea turtles from significant change in a biologically important behavior was considered negligible to minimal. Any auditory masking in fish, sharks or sea turtles is expected to be of minimal significance and, if occurring, would be temporary (DON, 2007). The potential impact on any stock of marine mammals from injury is considered to be negligible, and the effect on the stock of any marine mammal from significant change in a biologically important behavior is considered to be minimal. Any momentary behavioral responses and possible indirect impacts to marine mammals due to potential impacts on prey species are considered not to be biologically significant effects. Any auditory masking in mysticetes, odontocetes, or pinnipeds is not expected to be severe and would be temporary (DON, 2007). Further, there will be no significant impact to socioeconomic resources.

NMFS issued the Final Rule for the taking of Taking and Importing Marine Mammals; Taking Marine Mammals Incidental to the U.S. Navy Operations of Surveillance Towed Array Sensor System Low Frequency Active Sonar in August 2007 (NMFS, 2007i). NMFS has determined that the incidental taking of marine mammals resulting from SURTASS LFA sonar operations would have a negligible impact on the affected marine mammal species or stocks over the 5-year period of LFA sonar operations. That assessment is based on a number of factors: (1) The best information available indicates that effects from SPLs less than 180 dB will be limited to short-term Level B behavioral harassment averaging less than 12 percent annually for all affected marine mammal species; (2) the mitigation and monitoring is highly effective in preventing exposures of 180 dB or greater; (3) the results of monitoring as described in the Navy's Comprehensive Report supports the conclusion that takings will be limited to Level B harassment and not have more than a negligible impact on affected species or stocks of marine mammals; (4) the small number of SURTASS LFA sonar systems (two systems in FY 2008 and FY 2009 (totaling 864 hours of operation annually), 3 in FY 2010 (totaling 1296 hours of operation annually), and 4 systems in FY 2011 and FY 2012 (totaling 1728 hours of operation annually) that would be operating world-wide; (5) that the LFA sonar vessel must be underway while transmitting (in order to keep the receiver array deployed), limiting the duration of exposure for marine mammals to those few minutes when the SURTASS LFA sonar sound energy is moving through that part of the water column inhabited by marine mammals; (6) in the case of convergence zone propagation, the characteristics of the acoustic sound path, which deflect the sound below the water depth inhabited by marine mammals for much of the sound propagation (see illustration 67 FR page 46715 [July 16, 2002]); (7) the findings of the Scientific Research Program on low-frequency sounds on marine mammals indicated no significant change in biologically important behavior from exposure to sound levels up to 155 dB; and (8) during the 40 LFA sonar missions between 2002 and 2006, there were only three visual observations of marine mammals and only 71 detections by the HF/M3 sonar, which all resulted in mitigation protocol suspensions in operations. These measures all indicate that while marine mammals will potentially be affected by the SURTASS LFA sonar sounds, these impacts will be short-term behavioral effects and are not likely to adversely affect marine mammal species or stocks through effects on annual rates of reproduction or survival. In addition, mortality of marine mammals is not expected to occur as a result of LFA sonar operations (NMFS, 2007i).

6.3.1.3 Atlantic Ocean, Offshore of the Northeastern United States

Based on the discussion in Section 6.2.12.5, the need for inert bombing training in W-102 East by P-3s will cease after 2009 due to the 2005 BRAC decision to consolidate East Coast P-3 squadrons at NAS Jacksonville (DON, 2008h).

6.3.1.4 Gulf of Mexico

6.3.1.4.1 Naval Explosive Ordnance Disposal School Training

The mission of the Naval Explosive Ordnance Disposal School (NEODS) is to detect, recover, identify, evaluate, render safe, and dispose of unexploded ordnance that constitutes a threat to people, material, installations, ships, aircraft, and operations. The NEODS facilities are located at Eglin AFB, Florida. The proposed training at Eglin involves recognizing ordnance, reconnaissance, measurement, basic understanding of demolition charges, and neutralization of conventional and chemical ordnance. MCM detonation is one important function of NEODS, which involves mine-hunting and mine-clearance operations (U.S. Air Force, 2004B).

The NEODS proposes to use the Gulf of Mexico waters off of SRI for a portion of the class. The NEODS would utilize areas approximately 2 to 6 km (1 to 3 NM) offshore of Test Site A-15, A-10, or A-3 for MCM training. The students would be taught techniques for neutralizing mines by diving and hand-placing charges adjacent to the mines. The detonation of small, live explosive charges adjacent to the mine disables the mine function. Inert mines are utilized for training purposes. This training would occur offshore of SRI six times annually, at varying times within the year (U.S. Air Force, 2004B).

During training, five charges packed with C-4 explosive material will be set up adjacent to the mines. A charge contains a total net explosive weight of nearly 3 kg (6 lbs), with C-4 comprising 2 kg (5 lbs) of the total. No more than five charges will be utilized over the two-day period. The five 2-kg (5-lb) C-4 charges will be detonated individually with a maximum separation time of 20 minutes between each detonation. The time of detonation will be limited to an hour after sunrise and an hour before sunset. MLOs/inert mines, VEMs, and other expended materials will be recovered and removed from the Gulf of Mexico waters when training is completed (U.S. Air Force, 2004B).

NEODS activities could potentially cause effects to geology, water quality, noise, biological and cultural resources, and artificial reefs. Detonations will likely disturb sediments and produce turbidity, but the effects are temporary and not considered significant. Activities conducted on or in the vicinity of sensitive habitats, such as natural or artificial reefs, could negatively affect the function of such structures as fish habitat. Cultural resources could also be damaged by the detonations or associated activities. However, environmental regulations require surveys for such resources, which should result in no effects.

C-4 is a common variety of military plastic explosive, and the explosive material RDX (also known as cyclonite or hexogen) makes up around 90 percent of C-4 by weight. According to the BO by NMFS concerning NEODS activities, bioaccumulation of RDX does not appear to be of concern in aquatic organisms, and there are no data to indicate biomagnification of RDX in fish and other animal tissues. RDX and any other chemical resulting from detonations would occur in extremely low concentrations and would be dispersed by wave and current action. The BO concludes that, although data is lacking, there appears to be no effects on sea turtles, marine mammals, or the marine environment in general.

Detonations would result in both pressure waves and noise in the marine environment. Effects to sea turtles and marine mammals could result from exposure to these metrics (U.S. Air Force, 2004B and 2004C). The BO by NMFS included calculations of sea turtles potentially affected before and after mitigation measures. After the implementation of the required measures, a total of six sea turtles are expected to be affected (lethally and non-lethally) over a five-year period. The number of marine mammals potentially affected as estimated by Eglin AFB is summarized in Table 6-15. NMFS has approved an incidental take permit for NEODS activities allowing for 14 dolphin takes by harassment (NMFS, 2006g).

Table 6-15. Number of Marine Mammal Exposed to Noise Due to NEODS Activities

Species	Density (per km^2)	Number of Animals Exposed to Level A Harassment from 30 Detonations per Year	Number of Animals Exposed to Level B Harassment from 30 Detonations per Year
Summer			
Bottlenose dolphin	0.81	0.21	3.96
Atlantic spotted dolphin	0.677	0.18	3.30
T. truncatus/S. frontalis	0.053	0.01	0.27
TOTAL		**0.40**	**7.53**
Winter			
Bottlenose dolphin	0.81	0.21	4.02
Atlantic spotted dolphin	0.677	0.18	3.36
T. truncatus/S. frontalis	0.053	0.01	0.27
TOTAL		**0.40**	**7.65**

U.S. Air Force, 2004B
km^2 = square kilometers; NEODS = Naval Explosive Ordnance Disposal School

6.3.1.4.2 Conversion of Two F-15 Fighter Squadrons to F-22 Fighter Squadrons at Tyndall AFB, Florida

The U.S. Air Force has identified the need to replace the F-15 aircraft with the new F-22 "Raptor" (U.S. Air Force, 2000). Advantages of the F-22 include the use of stealth technology, sophisticated radar and electronic systems, and the ability to fly at supersonic speeds without using afterburners. The Air Force proposes to convert two of the three F-15 Fighter Squadrons at Tyndall AFB, Florida, to F-22 Fighter Squadrons. The conversion would occur over a five-year period with a continual reduction of F-15s lasting three or more years. This plan relies on a gradual transition of aircraft with the total number of aircraft stationed at Tyndall AFB slowly increasing to a maximum of 104 during FY 2008 and ending with a total number of 87 in FY 2011. At the end of the conversion, a single F-15 Fighter Squadron would remain at Tyndall. A total of 60 F-22s would ultimately be assigned to Tyndall (U.S. Air Force, 2000).

Due to the introduction of a new aircraft, the total number of sorties would increase by approximately 26 percent during the peak year (FY 2008). Starting at the end of the conversion (FY 2011), a 7 percent annual increase over current operations is anticipated. Around Tyndall AFB, the increase in airspace use is approximately three operations per hour, and in the special use areas (military airspace), the increase averages approximately two sorties per day (U.S. Air Force, 2000). Table 6-16 shows the estimated annual number of sorties throughout the conversion period.

Table 6-16. Estimated Annual Number of Sorties Associated with F-22 Conversion at Tyndall AFB

Aircraft	Current	Peak Year FY 2008	Changes in Sorties Current to Peak	End-State FY 2011	Changes in Sorties Current to End-State
F-15	16,688	8,783	-7,905	5,270	-11,418
F-22	0	12,222	+12,222	12,600	+12,600
Cumulative Total	**16,688**	**21,005**	**+4,317**	**17,870**	**+1,182**

Source: U.S. Air Force, 2000

Two major airspace actions are proposed: (1) expanded utilization of currently used special airspace, and (2) expanded use of other available special use airspace in the region. The over-water airspace proposed for use includes W-470, W-151, and W-168 (U.S. Air Force, 2000). The estimated annual number of sorties is summarized in Table 6-17.

Table 6-17. Estimated Annual Number of Sorties by Airspace Associated with F-22 Conversion at Tyndall AFB

Airspace	Baseline (FY 1998)	Peak (FY 2008)		End-State (FY 2011)	
	F-15	F-15	F-22	F-15	F-22
W-470 A	4,391	2,249	1,791	1,350	1,846
W-470 B	3,180	1,628	1,297	977	1,337
W-470 C	1,205	617	491	370	507
W-151 A,B	856	510	670	306	690
W-151 C,D	857	451	1,403	271	1,446
W-168	0	65	2,326	39	2,398
Total by Aircraft	**10,489**	**5,520**	**7,978**	**3,313**	**8,224**
Total by Year	**10,489**	**13,498**		**11,537**	

Source: U.S. Air Force, 2000

F-22 training would result in an increase in the quantities of chaff and flares expended, the majority of which are expended over water ranges (U.S. Air Force, 2000). As part of the program, the Air Force proposes to train pilots in the use of the internal aircraft gun. This would consist of shooting 20-mm inert training rounds at targets towed by an F-15 aircraft. The aerial gunnery training would occur only in W-470 and W-151. Tyndall currently does not utilize 20-mm training as part of F-15 training (U.S. Air Force, 2000). The estimated quantities of chaff bundles, flares, and 20-mm rounds are shown in Table 6-18.

Table 6-18. Estimated Annual Number of Chaff and Flare Expenditures Associated with F-22 Conversion at Tyndall AFB

Airspace	Baseline (FY 1998)		Peak Year (FY 2008)			End-State (FY 2011)		
	Chaff	Flares	Chaff	Flares	20 mm	Chaff	Flares	20 mm
W-470 A	128,042	64,021	91,882	45,941	45,967	72,682	36,341	45,967
W-470 B	92,717	46,359	66,533	33,266	45,967	52,630	26,315	45,967
W-470 C	35,146	17,573	25,221	12,610	4,086	19,950	9,975	4,086
W-151 A,B	24,970	12,485	26,819	13,410	3,065	22,655	11,327	3,065
W-151 C,D	24,984	12,492	42,164	21,082	3,065	39,048	19,524	3,065
W-168	0	0	54,382	27,191	0	55,423	27,711	0
Over-water Total	**305,859**	**152,930**	**307,001**	**153,500**	**102,150**	**262,388**	**131,193**	**102,150**

Source: U.S. Air Force, 2000

Increased noise produced in the Warning Areas is expected to be inconsequential (U.S. Air Force, 2000).

Training activities would result in extremely small (maximum of 0.04 percent of background in W-470) quantities of chemical elements such as aluminum and magnesium being added to the marine waters of the Gulf of Mexico. These additions are too small to affect Gulf of Mexico waters or any of the biological resources found there. The levels would be further reduced through the physical movements of tides, currents, waves, and wind, which serve to disperse chemical materials (U.S. Air Force, 2000). In addition, there is a potential for increased noise levels within the W-470 area. However, based on the location of Tyndall AFB and its close proximity to the Gulf of Mexico, the majority of flights including takeoffs and landing would not occur over populated areas.

6.3.1.4.3 B61 Joint Test Assembly Weapons Systems Evaluation Program

Air Combat Command (ACC) has requested the use of Eglin AFB as an alternative to the Department of Energy's (DOE) Tonopah Test Range for conducting B61 Joint Test Assembly (JTA) Weapons Systems Evaluation Program (WSEP) flight tests (U.S. Air Force, 2004c). The military has nuclear weapons in active inventory, which are full-up weapons ready for use, called war reserve (WR) nuclear weapons. Every year a certain number of these WR nuclear weapons are randomly selected to be shipped to a DOE production facility where selected parts from those WR weapons are used to build a JTA. The JTAs are then flight tested to assess the performance of the WR parts. Each JTA retains as many of the WR components as possible including portions of the explosive package, but no JTA configuration is capable of providing a nuclear detonation (U.S. Air Force, 2004c).

The goal for the testing is high-speed, low- and high-altitude release on Test Area (TA) B-70 (U.S. Air Force, 2004c). The desired target will be an 8,361 m^2 (91 m x 91 m [300 x 300 ft]) concrete pad constructed on TA B-70. Additional testing would include a shallow-water drop in the Gulf of Mexico (W-151 in less than or equal to 15 m [50 ft] depth). Aircraft drop JTAs during flight following a predetermined altitude (152 to 1,829 m [500 to 6,000 ft]) as directed by Flight Safety. The JTAs would be immediately removed after each test. Therefore, other on-site assets may include chase boats used in the retrieval of the JTA from the Gulf of Mexico target drop areas (U.S. Air Force, 2004c). The preferred testing scenario involves one JTA drop every two years for each profile on both TA B-70 and W-151 (Table 6-19).

Table 6-19. JTA WSEP Flight Test Proposed Action (per Two-Year Period)

Profile	B-70	EGTTR W-151 Shallow-Water Drop
Freefall Air (FFA) – parachute	1	1
Retarded Ground (REG) – parachute	1	1

Source: U.S. Air Force, 2004c
EGTTR = Eglin Gulf Test and Training Range; JTA = Joint Test Assembly; WSEP = Weapons Systems Evaluation Program

The chemical materials of interest for the B61 JTA testing are depleted uranium, thermal batteries, neutron generators, and other hazardous materials and explosives. All other explosives and hazardous materials contained in the B61 JTA are classified Secret and cannot be identified or discussed in detail (U.S. Air Force, 2004c).

These activities may potentially affect water quality and biological resources (protected species) (U.S. Air Force, 2004c). Although the B61 JTA spin rocket and motor would produce explosive products that may enter Gulf of Mexico waters, these amounts are minimal and are not expected to produce any environmental effects. The B61 JTA would be immediately retrieved upon entry into the Gulf of Mexico, and the neutron generator should remain intact. Calculations regarding the possible direct physical strike of a protected marine animal suggest that only 0.000045 dolphins and 0.00000895 sea turtles would be affected per test. These numbers are so low as to be discountable (U.S. Air Force, 2004c).

6.3.1.4.4 Fiber Optic Cable Installation

There is a proposal for Eglin AFB to partner with Gulf Fiber Corp. and the U.S. Navy to bring an armored fiber optic cable from the Gulf of Mexico to either Panama City, Florida, or Eglin property on SRI (U.S. Air Force, 2004a). If the cable goes to Eglin property, it would be run to Test Site A-3, and from there would be connected to the AT&T backbone near U.S. Highway 98.

Gulf Fiber Corp. is developing a fiber network between production oil platforms off Texas, Louisiana, Mississippi, and Alabama, and would provide the military with fiber conductivity into the Gulf of Mexico. This capability would support joint Gulf Test and Training Range operations (U.S. Air Force, 2004a). Figure 6-4, Figure 6-5, and Figure 6-6 show the current fiber optic ring, a proposed pathway from an oil platform to A-3, and possible future routes.

Resources potentially affected by the cable installation include geology, biological resources, and cultural resources (U.S. Air Force, 2004a). Installation of the cable would necessitate the disturbance of the sea floor for relatively long distances. The proposed pathways could intersect with EFH, artificial reefs, and submerged cultural resources (U.S. Air Force, 2004a).

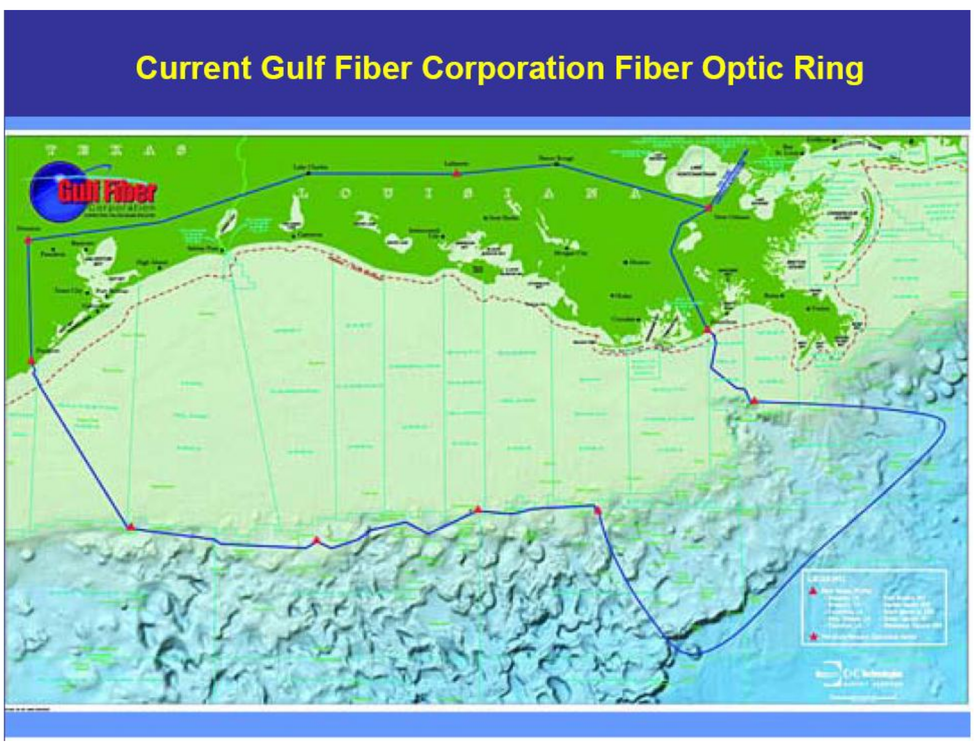


Figure 6-4. Existing Fiber Optic Ring in the Gulf of Mexico
Source: U.S. Air Force, 2004a

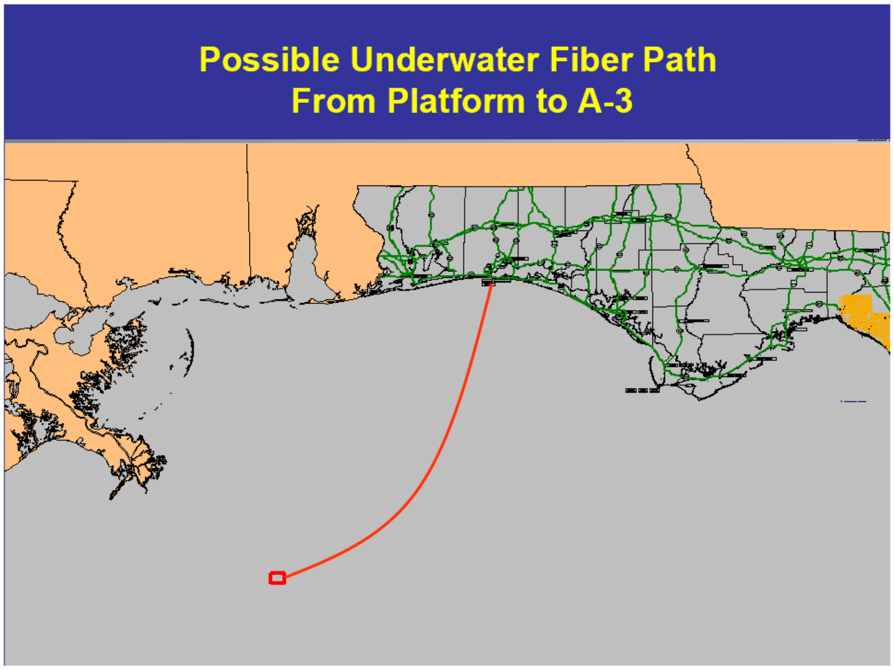


Figure 6-5. Proposed Fiber Optic Cable Pathway from Oil Platform to A-3
Source: U.S. Air Force, 2004a

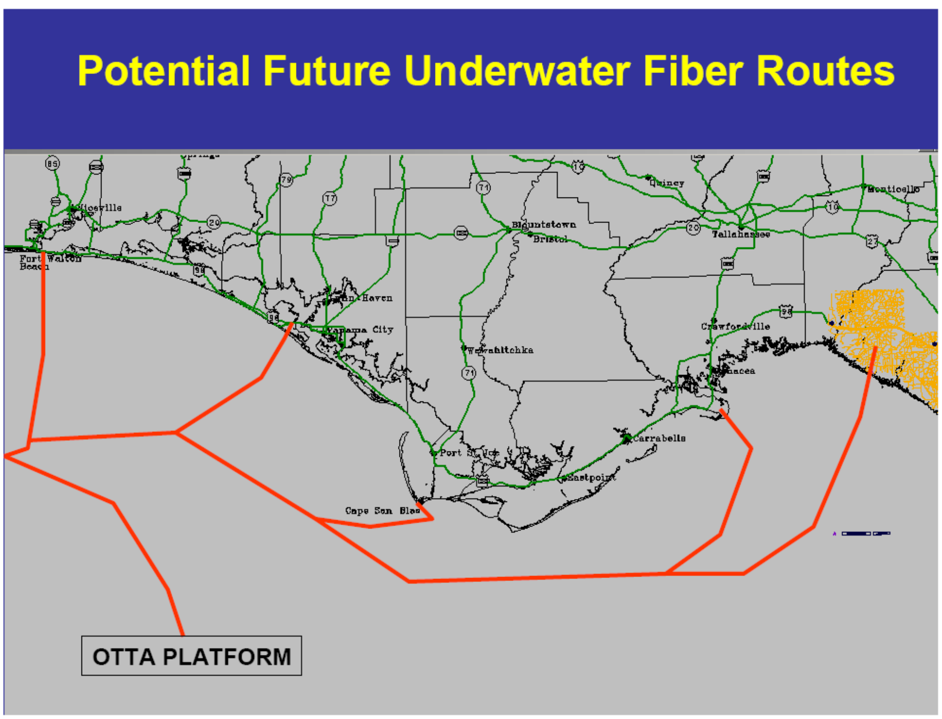


Figure 6-6. Potential Future Fiber Optic Cable Pathways
Source: U.S. Air Force, 2004a

6.3.1.4.5 NAS Corpus Christi

The Navy does not expect any increase in activities taking place in the Corpus Christi Area. Refer to Section 6.2.12.7.1 for further details on the activities that will be happening in the area (DON, 2008i).

6.3.2 Onshore and Offshore Liquefied Natural Gas (LNG) Facilities

6.3.2.1 LNG Atlantic Ocean, Offshore of the Southeastern United States

There are currently no proposed FERC or MARAD/USCG regulated LNG terminals offshore of the southeastern United States (FERC, 2007).

6.3.2.2 LNG Atlantic Ocean, Offshore of the Northeastern United States

Two terminals have been proposed and approved by MARAD/USCG offshore of Boston, Massachusetts (FERC, 2007).

6.3.2.2.1 Approved LNG Facilities, Northeastern United States

Fall River, Massachusetts LNG Terminal Project

Weaver's Cove Energy has proposed the development of a 30-hectare (73-acre) LNG terminal in Fall River, MA, which will consist of an LNG ship unloading jetty, a storage tank and vaporization system, and truck loading facilities. This project will require the Taunton River to be dredged in order to accommodate a turning basin. The terminal is planned for the eastern shore of the Taunton River. On July 28, 2006, the Commonwealth of Massachusetts approved the Environmental Impact Report for the project after determining that it complies with the Massachusetts Environmental Policy Act. The FERC approved the project on July 19, 2006, after declining requests for a rehearing on the project made by several agencies. Construction on the terminal, which is the only LNG plant approved by FERC in New England, will begin in early 2008. The plant should enter service in 2010-2011 (Weaver's Cove Energy, 2005).

Gloucester, Massachusetts Offshore LNG Project

Two LNG pipelines projects, the Northeast Gateway and Neptune projects, were proposed in the ocean off Gloucester, Massachusetts, approximately 30 miles north of Boston. Both projects involve offshore buoy systems connected to pipelines, allowing ships to offload LNG while at sea.

The Northeast Gateway project, owned by Excelerate Energy LLC is located in Massachusetts Bay approximately 21 km (11 NM) offshore. On May 14, 2007, MARAD issues a license for the ownership, operation, and construction of this port (MARAD, 2008). Construction was completed in December 2007, with final operating approvals received in February 2008 (Northeast Gateway, 2008). On February 27, 2008, Northeast Gateway submitted a request for Incidental Harassment Authorization for the period of May 2007 to May 2008 be extended for the operating period of May 2008 to May 2009 (Tetra Tech, 2007). The authorization would permit the Level B harassment of six ESA-listed marine mammals and 14 non-ESA-listed marine mammals for a maximum of 65 hours over one operating year (Tetra Tech, 2007).

The Neptune project, owned by SUEZ Energy North America, will be located approximately 16 km (8.6 NM) offshore the coast of Massachusetts' North Shore, (SUEZ Energy North America, 2008b). The proposed location will avoid Stellwagen Bank National Marine Sanctuary and the shipping lanes into Boston Harbor (SUEZ Energy North America, 2008b). On March 26, 2007, MARAD issues a deepwater port license for the ownership, operation, and construction of a LNG receiving and regasification facility (MARAD, 2008).

6.3.2.2.2 Proposed LNG Facilities, Northeastern United States

Passamaquoddy Bay, Maine LNG Projects

The Quoddy Bay LNG project is a partnership between the Passamaquoddy Tribe and the Quoddy Bay energy development company to construct a LNG import and regasification complex on the Pleasant Point Reservation in Washington County, Maine. The facility has not been approved by FERC; however, construction is expected to begin in 2008, and it is anticipated that the plant will be fully operational in early 2011 (Quoddy Bay, 2007).

The Downeast LNG project is planned for an area in the Passamaquoddy Bay near Robbinston, Maine. The project consists of LNG terminals and storage. The project has not been approved by FERC (Downeast LNG, 2007).

A third LNG terminal in the area is planned in the Red Beach section of the Passamaquoddy Bay in northern Maine. The Saint Croix Development Group is planning the facility, which will include a receiving terminal and LNG storage. The project has not been approved by FERC (Gulf of Maine Times, 2005).

Sparrows Point LNG Proposal – Sparrows Point, MD

In January of 2007, AES Sparrows Point LNG, LLC submitted an application to FERC for the construction and operation of a LNG or LNG import and re-gasification facility located at the Sparrows Point Industrial Complex near Baltimore, Maryland. The project will include a marine receiving terminal, three full containment 160,000 m^3 (209,272 yd^3) storage tanks, and facilities to support ship berthing and cargo offloading. Construction is expected to begin in 2008 and be completed in 2010. A Final EIS is currently being prepared and expected to be released later this year (AES Sparrowpoint, 2007).

Long Island Sound LNG

Broadwater Energy, LLC proposed the construction and operation of a floating storage and regasification unit for LNG in Long Island Sound approximately 14 km (7.5 NM) off the shore of Long Island in New York waters and approximately 18 km (9.7 NM) off the Connecticut shoreline. The project is a joint venture between TCPL USA LNG, Inc. (a subsidiary of TransCanada Corporation) and Shell Broadwater Holdings LLC (a subsidiary of Shell Oil

Company). In November 2006, Broadwater Energy LLC submitted a Draft EIS to FERC. After some modifications to mitigate certain environmental, safety, and security concerns, the FERC found that there would be limited adverse impact to the Long Island Sound. Broadwater plans to begin operation in 2010 (Broadwater Energy, 2007).

Safe Harbor Energy

The Atlantic Sea Island Group LLC is proposing to construct, own, and operate a LNG receiving, storage, and regasification facility called Safe Harbor Energy. Upon completion, it will be capable of delivering up to 0.07 billion yd^3 (2 billion ft^3) of natural gas per day to the New York metropolitan region. The facility will be located on an island to be constructed in federal waters on the Outer Continental Shelf, approximately 22 km (11.8 NM) south of the city of Long Beach, New York, on Long Island and 37 km (20 NM) southeast of the New York Harbor entrance. Atlantic Sea Island Group, LLC has taken the first steps in the NEPA process by completing the application and starting to prepare an EIS. Safe Harbor Energy anticipates the first shipment of LNG to the facility in 2014 (Safe Harbor Energy, 2007).

6.3.2.3 LNG Eastern Gulf of Mexico

There are currently no proposed and approved FERC or MARAD/USCG regulated LNG terminals in the eastern Gulf of Mexico. However, two terminals, one off the western coast of Florida and the other in the eastern Gulf of Mexico have been proposed to MARAD/USCG and are awaiting a decision (FERC, 2007).

6.3.2.4 LNG Western Gulf of Mexico

The western Gulf of Mexico is the only region in which a MARAD/USCG-regulated LNG terminal (Gulf Gateway Energy Bridge - Excelerate Energy) has been constructed (FERC, 2007). This offshore LNG receiving facility was established 187 km (101 NM) offshore the coast of Louisiana (Excelerate Energy, 2008).

6.3.3 MMS Regulated Activities: Alternative Energy Development (Offshore Wind, Wave, and Ocean Current Energy Capture)

United States Department of the Interior, MMS, released a final programmatic EIS in support of the establishment of a program for authorizing AEAU activities on the OCS, as authorized by Section 388 of the EPAct, and codified in subsection 8(p) of the OCSLA. The final programmatic EIS examines the potential environmental effects of the program on the OCS and identifies policies and best management practices that may be adopted for the program.

Offshore wind farms are being used in a number of countries to harness the energy of the moving air over the oceans and converting it to electricity. At present, the only wind farms worldwide are located off the coasts of Europe in waters 30 m (98 ft) deep or less. These wind farms currently harness just over 600 megawatts (MW) of offshore wind energy. However, offshore wind projects proposed worldwide through 2010 would produce more than 11,000 MW. Of these proposed projects, wind farm energy production in the United States would amount to roughly 500 MW (MMS, 2007e). With the passage of the Energy Policy Act of 2005, MMS was given jurisdiction over offshore alternative energy projects, including wind farms (MMS, 2007d).

Construction and everyday operation of offshore wind farms has the potential to affect several environmental resources, especially biological resources. Potential effects might include bird collisions with rotors or towers, increases in underwater noise due to construction and operational vibrations, the creation of underwater electromagnetic fields, and sea floor alterations due to installation (MMS, 2007e).

6.3.3.1 MMS – Atlantic Ocean, Offshore of the Southeastern United States

There are currently no proposed wind farm activities in this area.

Ocean Renewable Power Company applied to the Federal Energy Regulatory Commission (FERC) for a preliminary permit for the SeaGen Ft. Lauderdale Project and SeaGen West Palm Beach Project on May 14, 2004. This permit was issued on March 16, 2005. Based on further research into this particular technology, it was determined that the SeaGen turbines were not ready for commercial deployment. As such, the OCGen™ technology was developed, which was determined to be more appropriate. A preliminary permit for the Ft. Lauderdale and West Palm Beach sites was filed on March 13, 2008 (Ocean Renewable Power Company, 2008a; 2008b). Both proposed projects would be located in the Gulf Stream Current and a cable would run to the shore. The proposed project coordinates for the Ft. Lauderdale proposed project site are as follows:

- 26º 05’ 53.18”N 79º 55’ 55.37”W
- 26º 04’ 08.56”N 79º 55’ 56.32”W
- 26º 05’ 51.41”N 79º 52’ 03.65”W
- 26º 04’ 06.8”N 79º 52’ 04.66”W

The proposed project coordinates for the Ft. Lauderdale proposed project site are as follows:

- 26° 47' 23.25" N 79° 51' 55.89" W
- 26° 45' 38.65" N 79° 51' 56.93" W
- 26° 47' 21.33" N 79° 48' 02.8" W
- 26° 45' 36.73" N 79° 48' 03.9" W

The overall surface area of the two proposed permits in the area of turbine deployment is approximately 21 km^2 (6 NM^2); however, both projects would be smaller in area (Ocean Renewable Power Company, 2008a; 2008b).

On November 3, 2008, in response to FERC’s Notice of Preliminary Permit Application Accepted for Filing and Soliciting Comments, Motions to Intervene, and Competing Applications for each project, it was determined that FERC has no authority to permit or license ocean energy projects on the OCS; Since such permitting actions are regulated by the MMS, it was recommended that FERC deny issuance of preliminary permits (FERC, 2008). No further information regarding the issuance of these preliminary permits is available to date.

6.3.3.2 MMS – Atlantic Ocean, Offshore of the Northeastern United States

6.3.3.2.1 Patriot Renewables, LLC-Proposed Buzzards Bay Wind Farm

Patriot Renewables, LLC is studying the feasibility of siting the South Coast Offshore Wind project in Buzzards Bay, located in Massachusetts (Patriot Renewables, 2006). This proposed wind farm would lie approximately 1.6 to 4.8 km (0.9 to 2.6 NM) offshore and be comprised of 90 to 120 turbines spaced 804 to 402 m (0.5 to 0.25 mi) apart (Patriot Renewables, 2006). Due to its proposed location within state-regulated waters, this wind farm would be regulated by the State of Massachusetts, not MMS.

6.3.3.2.2 Cape Wind Offshore Wind Farm on Nantucket Sound

Cape Wind Associates, LLC has proposed the establishment of a wind farm project in federal waters of Nantucket sound off Massachusetts. The wind farm would be located 8.05 km (2.17 NM) or more from shore and consist of 130 turbines over an area of 62.16 km^2 (18.1 NM^2) (MMS, 2007d). The Cape Wind offshore wind farm would produce roughly over 1.4 million MW-hours per year, and save the area an estimated $800 million in energy costs over the next 20 years (Cape Wind, 2007). An EIS for this project is currently being prepared (MMS, 2007d).

6.3.3.2.3 Long Island Power Authority Offshore Wind Farm on Southside of Long Island Sound, New York

Long Island Power Authority (LIPA) and Florida Power and Light Energy propose the development of the Long Island Offshore Wind Park project in federal waters about 5.8 km (3.6 mi) south of Jones Beach Island, Long Island, New York. This proposed wind farm would consist of 40 turbines covering 20.72 km^2 (6.03 NM^2) (MMS, 2007f). The Long Island Offshore Wind Park would produce about 435,000 MW-hours per year, and would decrease the amount of fossil fuels required for energy production by an estimated $810 million over the course of 20 years (LIPA, 2007a and 2007b).

6.3.3.3 MMS – Eastern Gulf of Mexico

There are currently no proposed wind farm activities in this area.

6.3.3.4 MMS – Western Gulf of Mexico

6.3.3.4.1 Galveston-Offshore Wind, LLC Wind Farm, Galveston, Texas

Galveston-Offshore Wind, LLC has proposed building a 150-MW wind farm about 11.27 km (6.08 NM) off the coast of Galveston Island, Texas (DOE, 2005). This wind farm would consist of 50 turbines, with a height of about 79.25 m (260 feet) and a turbine blade length of approximately 50.29 m (55 yards). Over the course of the 30-year land lease (of 4,595.21 hectares [11,355 acres]) signed by Galveston-Offshore Wind, LLC, the amount of electricity produced by the wind farm would be equivalent to the amount of electricity produced by burning 20.7 million barrels of oil (Texas General Land Office [TGLO], 2005). Due to the proposed wind farm location within state-regulated waters, it would be regulated by the State of Texas, not MMS.

6.3.3.4.2 Superior Renewables Wind Farm, Padre Island, Texas

Superior Renewable Energy LLC has proposed the construction of a wind farm 4.8 to 12.87 km (3 to 8 mi) off the coast of Padre Island, south of Baffin Bay. Superior Renewable Energy LLC has been granted a 30-year land lease from the State of Texas for 16,146.96 offshore hectares (39,900 offshore acres) (TGLO, 2006). Because the wind farm would be located in State waters, the State of Texas would regulate all activities, not MMS. It is estimated that over 100 turbines will be installed to produce 500 MW of electricity (Washington Post, 2006). The amount of energy produced over the course of the 30-year lease by this wind farm would be equivalent to the amount of energy produced by burning 69 million barrels of oil. Due to the proposed wind farm location within state-regulated waters, it would be regulated by the State of Texas, not MMS.

Environmental concerns that have been raised in regard to the development of this wind farm have dealt with the possibility of bird strikes and effects on bird migration patterns (TGLO, 2006).

6.3.4 Maritime Traffic, Commerce, and Shipping Lanes

6.3.4.1 Proposed Marine Container Terminal at the Charleston Naval Complex

There are five marine terminals in the Charleston Harbor area that are owned and operated by the South Carolina State Ports Authority (SCSPA). North Charleston Terminal, Columbus Street Terminal, and Wando Welch Terminal are primarily container terminals and Union Pier and Veterans terminals are dedicated break-bulk facilities (SCSPA, 2008). Combined, the terminals comprise over two million square feet of warehouse and storage space and can accommodate more than 17 vessels at a time (City of North Charleston, 2008). Channels leading to the terminals are deep and wide enough to handle 8,000 twenty-foot equivalent (TEU) ships. All terminals are located within two hours of the open sea (SCSPA, 2008).

In 2004, the Port of Charleston handled approximately 1.725 million 20-foot equivalent units (TEU) (USACE, 2004c). The volume of containerized cargo is projected to increase 4.28 percent per year and will reach four million TEUs by the year 2025 (SCSPA, 2008; USACE, 2007d). To accommodate the increase in future demand for the number of containers that pass through the Port of Charleston each year, construction of a sixth terminal was permitted in 2007 (USACE, 2007d). This port facility will be located on the Cooper River approximately (0.9 km^2) (0.3 mi^2) of land at the south end of the former Charleston Navy Base in North Charleston, South Carolina (USACE, 2007d).

It is estimated that the baseline vessel traffic on the Cooper River will increase from 1,365 trips per year in 2004 to 3,219 trips per year in 2025 (USACE, 2006). This equates to an increase from 3.7 trips per day in 2004 to 8.8 trips per day in 2025, or just over five trips per day over a 21-year period. The proposed facility is estimated to be operational in 2012 (USACE, 2006).

6.3.4.2 Port Access Route Study

The Coast Guard is conducting a Port Access Route Study (PARS) on the area east and south of Cape Cod, Massachusetts, to include North Atlantic right whale critical habitat, mandatory ship reporting system area, and the Great South Channel including Georges Bank out to the exclusive economic zone (EEZ) boundary (Coast Guard, 2007). The purpose of the PARS is to analyze potential vessel routing measures that might help reduce ship strikes with the highly endangered North Atlantic right whale while minimizing any adverse effects on vessel operations. The recommendations of the study will inform the Coast Guard and may lead to appropriate international actions.

6.3.5 Implementation of Vessel Operational Measures to Reduce Ship Strikes to North Atlantic Right Whales

In August 2008, NMFS released a Final EIS to analyzes the potential effects associated with the implementation of vessel operational measures in waters off the East Coast of the United States to reduce vessel collisions with the endangered North Atlantic right whale (NMFS, 2008e). The proposed action addresses the lack of recovery of the North Atlantic right whale population by reducing the probability and threat of ship strike related deaths and serious injuries to the species.

Due to regional differences in right whale distribution and behavior, oceanographic conditions, and ship traffic patterns, the proposed vessel operational measures would apply only in certain areas and at certain times of the year, or under certain conditions. To account for regional variations, the U.S. East Coast is divided into three regions: northeastern United States (NEUS), mid-Atlantic United States (MAUS), and southeastern United States (SEUS). All vessels 19.8 m (65 ft) and greater in overall length and subject to US jurisdiction would be required to abide by the operational measures, except for vessels owned or operated by, or under contract to the Federal government, and law enforcement vessels of a state, or political subdivision thereof, when engaged in enforcement or human safety missions. An additional exemption would apply for vessels to maintain safe maneuvering speed under certain conditions. The measures considered include the following:

- **Seasonal Management Areas (SMAs).** SMAs are predetermined and established areas within which seasonal speed restrictions apply.
- **Dynamic Management Areas (DMAs).** DMAs are temporary areas consisting of a circle around a confirmed right whale sighting. The radius of this circle expands incrementally with the number of whales sighted and a buffer is included beyond the core area to allow for whale movement. Speed restrictions apply within DMAs, which may be mandatory or voluntary and apply only when and where no SMA is in effect.
- **Routing Measures.** These consist of a set of routes designed to minimize the co-occurrence of right whales and ship traffic. Use of these routes is voluntary; therefore, they constitute a non-regulatory measure. However, mandatory speed restrictions would

apply in the portions of the routes located within an active SMA. NMFS would monitor these routes and consider making them mandatory if use is low.

Within the proposed SMAs (when in effect) and DMAs (when in effect), NMFS' proposed restriction is 19 kilometers/hour (km/hr) (10 knots (kn); however, for comparison purposes, the FEIS also considers speed limits of 22 and 26 km/hr (12 and 14 kn). The following six alternatives were considered:

1. Alternative 1-No Action.
2. Alternative 2-Mandatory DMA.
3. Alternative 3-Speed restrictions in designated areas.
4. Alternative 4-Recommended shipping routes.
5. Alternative 5-Combination of Alternatives 1 through 4.
6. Alternative 6-Proposed Action and Preferred Alternative.
   - In the SEUS region, Southeast SMA and recommended routes.
   - In the MAUS region, separate SMAs (37 km [20 NM] SMAs option).
   - In the NEUS region, Cape Cod Bay SMA, Off Race Point SMA, and Great South Channel GSC SMA, as well as recommended routes.
   - In all three regions, Voluntary DMAs.

Not all vessel operation measures are considered for all regions. The specific measures considered for each of the three regions of implementation are shown in Table 6-20.

The EIS analyzed potential effects to the North Atlantic right whale, other marine species, physical environment, port areas and vessel operations, commercial fishing vessels, ferry vessels and ferry passengers, whale-watching vessels, charter vessels, environmental justice, and cultural resources. For the purposes of the cumulative impacts analysis in this EIS/OEIS, the Preferred Alternative, Alternative 6, will be discussed. It was determined that there would be a direct positive effect on right whale populations and indirect positive effects on marine mammals and sea turtles. In addition, implementation of Alternative 6 would result in negligible impacts on water quality in the NEUS had minor adverse impacts in the SEUS, as well as minor, direct positive effects to ocean noise. There would be only minimal impact on the financial revenues of port vessel operators, commercial fishing vessels, and charter vessels. There would be annual financial adverse effects to ferry vessels and ferry passengers and whale-watching vessels. There were no environmental justice concerns identified and no effects to cultural resources (NMFS, 2008e).

In addition, effective December 9, 2008 through December 9, 2013, speed restrictions of no more than 18.5 km/hr (10 kn) will apply to all vessels 19.8 m (65 ft) or greater in overall length in certain locations and at certain times of the year along the east coast of the U.S. Atlantic seaboard (NMFS, 2008i). The purpose of the regulations is to reduce the likelihood of deaths and serious injuries to North Atlantic right whales that result from collisions with ships. These restrictions are not mandatory for naval vessels (NMFS, 2008i).

The EIS analyzed potential effects to the North Atlantic right whale, other marine species, physical environment, port areas and vessel operations, commercial fishing vessels, ferry vessels and ferry passengers, whale-watching vessels, charter vessels, environmental justice, and cultural resources. For the purposes of the cumulative impacts analysis in this EIS/OEIS, the Preferred Alternative, Alternative 6, will be discussed. It was determined that there would be a direct positive effect on right whale populations and indirect positive effects on marine mammals and sea turtles. In addition, implementation of Alternative 6 would result in negligible impacts on water quality in the NEUS had minor adverse impacts in the SEUS, as well as minor, direct positive effects to ocean noise. There would be only minimal impact on the financial revenues of port vessel operators, commercial fishing vessels, and charter vessels. There would be annual financial adverse effects to ferry vessels and ferry passengers and whale-watching vessels. There were no environmental justice concerns identified and no effects to cultural resources (NMFS, 2008e).

Table 6-20. Summary of Proposed Operational Measures by Region

Region	Proposed Measures	Period of Application	Alternative
Southeast	Southeast SMA off the coast of Georgia and Florida, bounded to the north by latitude 31º27'N, to the south by latitude 29º45'N, to the east by longitude 80º51.6'W, and to the west by the shoreline.	November 15 to April 15	6
	or		
	SMA including all waters within the Mandatory Ship Reporting System WHALESSOUTH reporting area and the presently designated right whale critical habitat	November 15 to April 15	3 and 5
	and/or		
	Recommended routes into and out of the ports of Jacksonville and Fernandina Beach, Florida, and Brunswick, Georgia.	Year-round	4, 5, and 6
Mid-Atlantic	Six Separate SMAs, including under one option a 56-km (30-NM)-wide rectangular SMA south and east of the mouth of Block Island Sound; SMAs with a 37 km (20 NM) radius around the entrances to the ports of New York/New Jersey, the Delaware Bay and Chesapeake Bay, and Morehead City and Beaufort, North Carolina; finally, a continuous SMA from the shore out to 37 km (20 NM) from Wilmington, NC, south to Brunswick, GA. Under another option, the 37 km (20 NM) SMAs would be 56 km (30 NM) in size.	November 1 to April 30	6 (20-NM SMAs Option)
	or		
	One continuous 46 km (25 NM) SMA between Block Island Sound and Savannah, GA.	October 1 to April 30	3 and 5

Table 6-20. Summary of Proposed Operational Measures by Region Cont'd

Region	Proposed Measures		Period of Application	Alternative
Northeast	Cape Cod Bay	CCB SMA, covering the entire bay, including the Cape Cod Bay critical habitat and the area directly west of the critical habitat to the shoreline.	January 1 to May 15	6
		or Critical Habitat SMA, coinciding with the designated critical habitat.	Year-round	3 and 5
		and/or Recommended Routes from Cape Cod Canal through the Critical Habitat, on the western side of the bay, towards Massachusetts Bay and other points north.	Year-round	4, 5, and 6
	Off Race Point	Off Race Point SMA, an area approximately 93 by 93 km (50 by 50 NM) in size to the north and east of Cape Cod.	March 1 to April 30	6
		or SAM West SMA, coinciding with the expanded SAM West identified in the ALWTRP.	Year-round	3 and 5
	Great South Channel	GSC SMA, within a defined area of the Great South Channel.	April 1 to July 31	6
		or SAM East SMA, coinciding with the expanded SAM East identified in the ALWTRP.	Year-round	3 and 5

Table 6-20. Summary of Proposed Operational Measures by Region Cont'd

Region	Proposed Measures	Period of Application	Alternative
Southeast, Mid-Atlantic, and Northeast	Mandatory DMAs throughout the EEZ **or** Voluntary DMAs throughout the EEZ	Year-round Year-round	2 and 5 6

Source: NMFS, 2008e

ALWTRP – Atlantic Large Whale Take Reduction Plan; CCB – Cape Cod Bay; DMAs – Dynamic Management Areas; EEZ- Exclusive Economic Zone; GSC – Great South Channel; km – Kilometer; MAUS – Mid-Atlantic United States; NM – Nautical Mile; NEUS – Northeastern United States; SAM –Seasonal Area Management; SMAs – Seasonal Management Areas; SEUS – Southeastern United States

This page is intentionally blank.

Effective December 9, 2008 through December 9, 2013, speed restrictions of no more than 18.5 km/hr (10 kn) will apply to all vessels 19.8 m (65 ft) or greater in overall length in certain locations and at certain times of the year along the east coast of the U.S. Atlantic seaboard (NMFS, 2008i). The purpose of the regulations is to reduce the likelihood of deaths and serious injuries to North Atlantic right whales that result from collisions with ships. These restrictions are not mandatory for naval vessels (NMFS, 2008i). In addition, in July 2007, the east-west leg of the Boston Traffic Separation Scheme was shifted approximately 12 degrees north to redirect shipping traffic through the Stellwagen Bank NMS from an area of high whale density to an area of significantly lower whale density.

6.4 DISCUSSION OF CUMULATIVE IMPACTS RELATIVE TO THE PROPOSED ACTION

6.4.1 Assessing Proposed Action Impacts

Where feasible, the cumulative impacts were assessed using quantifiable data. However, in that quantifiable data was not always available; this analysis utilized qualitative information where necessary. For example, commercial shipping, commercial and recreational fishing, boating, and other activities occurring are not required to comply with the NEPA or analyze potential effects; therefore, there is little to no analysis data available for these activities. Since a quantitative analysis of potential effects for these areas is not possible; qualitative information, such as known marine species injuries or deaths was used as appropriate. In addition, since an analysis of potential environmental effects for future actions (identified in Section 6.3) has not been completed, assumptions based on past actions were used.

All past, present, and reasonably foreseeable future military activities described in this chapter are grouped together under Military Operations. It should be noted that the individual military actions tend to affect different resources, and when grouped together should not be interpreted to mean that each military activity would affect all resources.

6.4.1.1 Sediment Contamination (Sediment Quality)

6.4.1.1.1 AFAST EIS/OEIS Conclusions

An update to the 1996 EA for the Canadian Forces Maritime Experimental and Test Ranges (CFMETR) near Nanoose, British Columbia, was completed in 2005 by Environmental Sciences Group, Royal Military College of Canada (ESG). This document analyzed chemical effects associated with expendable components from activities involving sonobuoys, torpedoes, EMATTs, and ADCs (ESG, 2005). Specifically, the analysis focused on lead, copper, lithium, and Otto fuel. The document stated that metal contaminants were most likely to concentrate in fine-grained particulate matter, especially when smaller than 63 μm. The findings of the EA demonstrated that CFMETR operations did not cause a measurable effect on sediment quality (ESG, 2005). Therefore, based on the conclusions of this EA and because AFAST active sonar activities involve activities similar in nature to those analyzed in the EA, it is anticipated that metal contaminants from expended materials during AFAST operations have the potential for a minor, but recoverable impact to sediments from expended materials. No significant impacts from AFAST active sonar activities are anticipated.

6.4.1.1.2 AFAST Incremental Contribution and Cumulative Effects from Other Projects and Activities (Past, Present, and Reasonably Foreseeable Future)

Any expending of materials at sea, over a long period of time, can cause potential incremental effects to sediment quality. However, the Study Area where the Proposed Action and actions previously described in this chapter are occurring is vast and chemical releases would rapidly dilute in the water; thus, accumulation of chemicals in sediments is not likely to occur. Therefore, it is expected that although there would be a potential for minor incremental, but recoverable, adverse cumulative effects, these effects would not be considered significant as they would be localized and temporary. No significant cumulative impacts to sediments from expended materials are anticipated from the No Action Alternative, Alternative 1, Alternative 2, or Alternative 3.

6.4.1.2 Marine Debris (Marine Habitat)

6.4.1.2.1 AFAST EIS/OEIS Conclusions

Expended materials will settle to the ocean bottom and will be covered by sediments over time. Due to the small size and low density of materials, these components are not expected to float at the water surface or remain suspended within the water column. Over time, the amount of materials will accumulate on the ocean floor. However, active sonar activities will not likely occur in the exact same location each time and, due to ocean current, the materials will not likely settle in the same vicinity.

6.4.1.2.2 AFAST Incremental Contribution and Cumulative Effects from Other Projects and Activities (Past, Present, and Reasonably Foreseeable Future)

Any expending of materials at sea, over a long period of time, can cause potential incremental effects to the marine habitat. However, the Study Area where the Proposed Action and actions previously described in this chapter are occurring is vast and the expended components are not expected to float at the water surface or remain suspended within the water column. For example over the next five years, SINKEX events would disperse expended materials over approximately 0.0000000074 percent of the ocean floor. Therefore, it is expected that although there would be a potential for minor incremental, but recoverable, adverse cumulative effects, these effects would not be considered significant. No significant cumulative impacts to the marine habitat from expended materials are anticipated from the No Action Alternative, Alternative 1, Alternative 2, or Alternative 3.

6.4.1.3 Water Quality

6.4.1.3.1 AFAST EIS/OEIS Conclusions

Chapter 4 analyzed the potential effects to water quality from sonobuoy, ADC, EMATT batteries, explosive sonobuoys (AN/SSQ-110A), and OF II combustion byproducts associated with torpedoes. XBTs were not analyzed since they do not use batteries. Moreover, the scuttling of sonobuoys were not analyzed since, once scuttled, their electrodes are largely exhausted during operations and residual constituent dissolution occurs more slowly than the releases from activated seawater batteries. As such, only the potential effects of batteries and explosions on marine water quality in and surrounding the sonobuoy operation area was completed. It was determined that there would be no significant impact to water quality from seawater batteries, lithium batteries, and thermal batteries associated with scuttled sonobuoys under the No Action Alternative, Alternative 1, Alternative 2, or Alternative 3.

ADCs and EMATTs use lithium sulfur dioxide batteries. The constituents in the battery react to form soluble hydrogen gas and lithium dithionite. The hydrogen gas eventually enters the atmosphere and the lithium hydroxide dissociates, forming lithium ions and hydroxide ions. The hydroxide is neutralized by the hydronium formed from hydrolysis of the acidic sulfur dioxide, ultimately forming water. Sulfur dioxide, a gas that is highly soluble in water, is the major reactive component in the battery. The sulfur dioxide ionizes in the water, forming bisulfite (HSO_3) that is easily oxidized to sulfate in the slightly alkaline environment of the ocean. Sulfur is present as sulfate in large quantities (i.e., 885 mg/L) in the ocean. Thus, it was determined that there would be no significant impact to water quality from lithium sulfur batteries associated with scuttled ADCs and EMATTs under the No Action Alternative, Alternative 1, Alternative 2, or Alternative 3.

In addition, it was determined that explosion residuals associated with the explosive source sonobuoy (AN/SSQ-110A) would not significantly impact the water quality under the No Action Alternative, Alternative 1, Alternative 2, or Alternative 3. This determination is based on the fact that only a very small percentage of the available hydrogen fluoride explosive product is expected to become solubilized prior to reaching the surface and rapid dilution would occur upon mixing with the ambient water.

OF II is combusted in the torpedo engine and the combustion byproducts are exhausted into the torpedo wake, which is extremely turbulent and causes rapid mixing and diffusion. Combustion byproducts include carbon dioxide, carbon monoxide, water, hydrogen gas, nitrogen gas, ammonia, hydrogen cyanide (HCN), and nitrogen oxides. All of the byproducts, with the exception of hydrogen cyanide, are below the EPA standards for marine water quality criteria. Hydrogen cyanide is highly soluble in seawater and dilutes below the EPA marine water quality criterion within 6.3 m (20.7 ft) of the torpedo. Therefore, it was determined there would be no significant impact to water quality as a result of OF II under the No Action Alternative, Alternative 1, Alternative 2, or Alternative 3.

6.4.1.3.2 AFAST Incremental Contribution and Cumulative Effects from Other Projects and Activities (Past, Present, and Reasonably Foreseeable Future)

Effects to water quality from past, present, and reasonably foreseeable future activities would most likely occur from the degradation of expended materials and increased turbidity due to localized disturbances of ocean bottom sediments caused by construction, dredging, and oil and gas industry activities. However, these effects would most likely be minor and temporary and would not have a significant impact on marine water quality. Moreover, water quality conditions would most likely return to normal after project completion. Therefore, when combined with construction, dredging, and oil and gas industry actions, AFAST active sonar activities under the No Action Alternative, Alternative 1, Alternative 2, or Alternative 3 are not expected to significantly impact marine water quality. Cumulative impacts would be minor, but recoverable and would not be significant.

6.4.1.4 Sound In The Environment

6.4.1.4.1 AFAST EIS/OEIS Conclusions

The potential cumulative impacts associated with active sonar activities focus on the addition of underwater sound to existing oceanic ambient noise levels, which in turn could have potential effects on marine animals. Anthropogenic sources of ambient noise that are most likely to contribute to increases in ambient noise levels are commercial shipping, offshore oil and gas exploration and drilling, and use of sonar (DON, 2007f). Although not part of the Proposed Action in this EIS/OEIS, potential operations for Surveillance Towed Array Sensor System (SURTASS) low-frequency active sonar vessels over the next five years, based on current operational requirements, will most likely include areas located in the Pacific, Indian, and Atlantic oceans, and the Mediterranean Sea (DON, 2007e). However, ongoing litigation over the SURTASS low-frequency active Supplemental EIS may minimize or preclude the use of SURTASS low-frequency active in and around the AFAST Study Area. Nonetheless, low-frequency active is included in this cumulative analysis. The potential impact that low, mid-, and high frequency sonars may have on the overall oceanic ambient noise level is reviewed in the following contexts:

- Recent changes to ambient sound levels in the Atlantic Ocean and Gulf of Mexico;
- Operational parameters of the sonar operating during AFAST active sonar activities, including proposed mitigation;
- The contribution of active sonar activities to oceanic noise levels relative to other human-generated sources of oceanic noise; and
- Cumulative impacts and synergistic effects.

Section 3.5 of this EIS/OEIS presents sources of oceanic ambient noise, which include physical, biological, and anthropogenic noise. Very few studies have been conducted to determine ambient sound levels in the ocean. However, ambient sound levels for the EGTTR, located in the Gulf of Mexico, generally range from approximately 40 dB to about 110 dB (U.S. Air Force, 2002). In a study conducted by Andrew et al. (2002), oceanic ambient sound from the 1960s was compared to oceanic ambient sound from the 1990s using a receiver off the coast of California (DON, 2007f). The data showed an increase in ambient noise of approximately 10 dB in the frequency range of 20 to 80 Hz and at 200 and 300 Hz, and about 3 dB at 100 Hz over a 33-year period (DON, 2007f).

Anthropogenic sound can be introduced into the ocean by a number of sources, including vessel traffic, industrial operations onshore, seismic profiling for oil exploration, oil drilling, and sonar operations. In open oceans, the primary persistent anthropogenic sound source tends to be commercial shipping, since over 90 percent of global trade depends on transport across the seas (Scowcroft et al., 2006). Container shipping movements represent the largest volume of seaborne trade. Moreover, there are approximately 20,000 large commercial vessels at sea worldwide at any given time. The large commercial vessels produce relatively loud and predominately low-frequency sounds. Most of these sounds are produced as a result of propeller cavitation (when air spaces created by the motion of propellers collapse) (Southall, 2005). In 2004, NOAA hosted a symposium entitled, "Shipping Noise and Marine Mammals." During Session I, Trends in the Shipping Industry and Shipping Noise statistics were presented that indicate foreign waterborne trade into the United States has increased 2.45 percent each year over a 20-year period (1981-2001) (Southall, 2005). International shipping volumes and densities are expected to increase in the foreseeable future (Southall, 2005). Although it is unknown how international shipping volumes and densities will continue to grow, current statistics support the prediction that the international shipping fleet will continue to grow at the current rate or at greater rates in the future. Shipping densities in specific areas and trends in routing and vessel design are as, or more, significant than the total number of vessels. Densities along existing coastal routes are expected to increase both domestically and internationally. New routes are also expected to develop as new ports are opened and existing ports are expanded. Vessel propulsion systems are also advancing toward faster ships operating in higher sea states for lower operating costs; and container ships are expected to become larger along certain routes (Southall, 2005). The increase in shipping volumes and densities will most likely increase overall ambient sound levels in the ocean. However, it is not known whether these increases would have an effect on marine mammals (Southall, 2005).

According to the NRC (2003), the oil and gas industry has five categories of activities which create sound: seismic surveys, drilling, offshore structure emplacement, offshore structure removal, and production and related activities. Seismic surveys are conducted using air guns, sparker sources, sleeve guns, innovative new impulsive sources and sometimes explosives, and are routinely conducted in offshore exploration and production operations in order to define subsurface geological structures. The resultant seismic data are necessary for determining drilling location and currently, seismic surveys are the only method to accurately find hydrocarbon reserves. Since the reserves are deep in the earth, source levels in the low frequency band (5 to 20 Hz) is of greatest value for seismic surveys, because lower frequency signals are able to travel farther into the seafloor with less attenuation (DON, 2007f).

Air gun firing rate is dependent on the distance from the array to the substrate. The typical intershot time is 9 to 14 seconds, but for very deep water surveys, inter-shot times are as high as 42 sec. Air gun acoustic signals are broadband and typically measured in peak-to-peak pressures. Peak levels from the air guns are generally higher than continuous sound levels from any other ship or industrial noise. Broadband SELs of 248 to 255 dB from zero-to-peak are typical for a full-scale array. The most powerful arrays have source levels as high as 260 dB, zero-to-peak with air gun volumes of 130 L (7,900 in^3). Smaller arrays have SELs of 235 to 246 dB, zero-to-peak.

For deeper-water surveys, most emitted energy is around 10 to 120 Hz. However, some pulses contain energy up to 1,000 Hz (Richardson et al., 1995), and higher. Drill ship activities are one of the noisiest at-sea operations because the hull of the ship is a good transmitter of all the ship's internal noises. Also, the ships use thrusters to stay in the same location rather than anchoring. Auxiliary noise is produced during drilling activities from sources such as helicopters and supply boats. Offshore drilling structure emplacement creates some localized noise for brief periods of time, and emplacement activities can last for a few weeks and occur worldwide. Additional noise is created during other oil production activities, such as borehole logging, cementing, pumping, and pile-driving. Although sound pressure levels for the other activities have not yet been calculated, sound pressure levels for pile-driving have. More activities are occurring in deep water in the Gulf of Mexico and offshore West Africa areas. These oil and gas industry activities occur year-round (not individual surveys, but collectively) and are usually operational 24 hours per day and 7 days per week, as compared to the limited and intermittent sonar transmissions.

Active sonar was probably the first wide-scale, intentional use of anthropogenic noise within the oceans. The outbreak of World War (WW) I in 1914 initiated the development of a number of military sonar applications (Urick, 1983). By 1935, several adequate sonar systems had been developed, and by 1938 with WWII imminent, production of sonar sets started in the U.S. (Urick, 1983).

There are both military and commercial sonars. Military sonars are used for target detection, localization, and classification while commercial sonars are used for depth sounding, bottom profiling, fish finding, and detecting obstacles in the water. Commercial sonars are typically higher in frequency and lower in power as compared with military sonars. Commercial sonar use is expected to continue to increase, although it is not believed that the acoustic characteristics will change (DON, 2007f).

The U.S. Navy will consult with NMFS to address potential effects to marine mammals and sea turtles from sound associated with AFAST active sonar activities under the ESA and the MMPA. Mitigation measures will be employed during AFAST active sonar activities to minimize potential effects to the greatest extent practicable. As such, the potential exists for moderate, but recoverable effects to occur to sea turtles and marine mammals from the introduction of sound into the environment. However, with the implementation of proper mitigations, no significant impacts are anticipated.

6.4.1.4.2 AFAST Incremental Contribution and Cumulative Effects from Other Projects and Activities (Past, Present, and Reasonably Foreseeable Future)

The potential for cumulative impacts and synergistic effects from all acoustic sources, including sonar, is analyzed in relation to overall oceanic ambient noise levels, including the potential for sound introduced by AFAST training to add to overall ambient levels of anthropogenic noise. Increases in ambient noise levels have the potential to cause masking, and decrease in distances that underwater sound can be detected by marine animals. These effects have the potential to cause a long-term decrease in a marine mammal’s efficiency at foraging, navigating, or communicating (DON, 2007f). In addition, it is possible marine mammals will experience acoustically-induced stress (NRC, 2003). However, sounds resulting from one-time exposure are less likely to have population-level effects than sounds that mammals are exposed to repeatedly over extended periods of time (NRC, 2003).

Merchant ships and sound of seismic surveys cover a wide frequency band and are long in duration. The majority of proposed AFAST active sonar activities is conducted away from harbors or heavily traveled shipping lanes. The loudest underwater sounds in the Study Area are those produced by hull-mounted mid-frequency active tactical sonar. High-frequency sonar, specifically above 200 kHz, would dissipate rather quickly and is unlikely to impact marine mammals. Mid-frequency active sonar signals are likely within the audible range of most cetaceans, but are very limited in the temporal and frequency domains. In particular, the pulse lengths are short, the duty cycle low, and active sonars transmit within a narrow band of frequencies (typically less than one-third octave). Low-frequency sonar will not be used during AFAST active sonar activities.

NRC (2003) stated that although techniques are being developed to identify indicators of stress in natural populations, determining the contribution of noise exposure to those stress indicators will be very difficult, but important, to pursue in the future when the techniques are fully refined. There are scientific data gaps regarding the potential for active sonar to cause stress in marine animals. Even though an animal's exposure to active sonar may be more than one time, the intermittent nature of the sonar signal, its low duty cycle, and the fact that both the vessel and animal are moving provide a very small chance that exposure to active sonar for individual animals and stocks would be repeated over extended periods of time, such as those caused by shipping noise. Since active sonar transmissions will not significantly increase anthropogenic oceanic noise, cumulative impacts and synergistic effects from stress are not reasonably foreseeable. Therefore, it is expected there would be a potential for minor incremental, but recoverable, cumulative impacts to ambient ocean sound from implementation of the No Action Alternative, Alternative 1, Alternative 2, or Alternative 3 when combined with the cumulative actions listed in the previous sections of this chapter.

6.4.1.5 Marine Mammals

6.4.1.5.1 AFAST EIS/OEIS Conclusions

In addition to underwater sound, activities that affect marine mammals include by-catch, ship strikes, and authorized takes. Changes in the environment from climate change induced by humans also threaten marine mammals. As discussed in Section 6.1, the greatest threat to cetacean mortality and injury occurs in the commercial fishing industry. More whales die every year through entanglement in fishing gear than from any other cause. Gillnets, set nets, trammel nets, seines, trawling nets and longlines pose the biggest threat. Gillnets contribute a very high proportion of global cetacean bycatch because of their low cost and widespread use. In the Northeast of the U.S., traps and pots are left in the water for extended periods of time. Whales may become entangled in the lines and have been observed swimming with portions of the gear wrapped around fins, flukes, the neck, and mouth. Animals may travel long distances over time before they free themselves of the gear or die from the entanglement (Angliss and Demaster, 1998). Scientists and the regulatory community have found that:

- Entanglements that caused serious injury most frequently involved humpback whales, followed by right whales, then minke and fin whales.

- Fatal entanglements most frequently involved minke whales, followed by humpback whales, right whales, and fin whales.
- Fatal entanglements were most frequently reported off the coast of Massachusetts. Additional fatal entanglements were reported off the coasts of North Carolina, Virginia, South Carolina, and Maine.

Johnson et al. (2005) studied 31 right whales and 30 humpback whales to determine specific types and parts of gear that these animals become entangled. Results of the study concluded that 89 percent of entanglements were attributed to pot and gill net gear. Of the suspected or known lethal entanglements, pot gear was involved in 18 percent and gill net gear was involved in 23 percent. Of the gear part identified, 81 percent of the involved entanglements were in either a buoy line or goundline. It was also noted that right whales gear attachment is primarily in the mouth (77.4 percent), while humpback whale gear attachment is primarily in the tail (53 percent) and mouth (43 percent). During this study, it is known that four right whales and three humpback whales died following an entanglement. The gear types and parts identified as being involved in these mortalities were not drastically different from the gear involved with non-lethal outcomes (Johnson et al., 2005).

Programs targeted specifically to address the effects on large whales from commercial fisheries include a gear research and development program to reduce the amount of potentially hazardous gear in the water and the disentanglement network whose personnel work to locate, assess, and remove gear from entangled whales.. Recommendations under the recovery plan specific for right whales to reduce commercial fishery interactions with whales include gear restrictions and modifications, research, and regulatory and enforcement actions (NMFS, 2007h).

Entanglements may also occur with recreational fishing gear. Little data exists for recreational fishing interactions with marine mammals. Large whale entanglements may also result from interactions with recreational fishing. Finfish recreational fisheries typically involve rod and reel and hand lines while traps/pots are common for the lobster and crab industry. The risk of entanglement in recreational gear is relatively small for marine mammals (NMFS, 2007h).

Marine mammals may be injured or killed from ship strikes throughout the world, including the AFAST Study Area. Since 1885, 292 ship strikes have been reported involving 11 different species. Of these documented cases, 198 were fatal, 48 included injury, 39 were unknown, and 7 showed no signs of injury (Jensen and Silber, 2004). In many injury cases, however, the fate of the whale is unknown (NMFS, 2007h).

The most vulnerable marine mammals are those whose behavioral characteristics cause them to remain at the surface for extended period of time, rather than merely those that remain at the surface to restore oxygen levels after deep dives. Laist et al. (2001) identified 11 species known to be hit by ships. Of these species, fin whales are struck most frequently; right whales, humpback whales, sperm whales, and gray whales are hit commonly. The review, which involved 58 known vessel collisions revealed that while all sizes and types of vessels can hit and injure whales, the most severe injuries result from collisions involving ships that are greater than 80 meters in length or traveling at speeds exceeding 13 knots (Laist et al., 2001).

Given the depleted nature of many of these stocks, this effect represents a potentially significant source of risk. For example, the total estimated ship strike mortality and serious injury for the endangered right whale between 1999 and 2003 was estimated at 1.0 whale per year (USA waters 0.8; Canadian waters, 0.2) (Waring et al., 2006). The behavior of right whales makes them particularly vulnerable to collisions. Right whales swim close to shore and in or adjacent to major shipping lanes. In addition, they spend much of their time at the surface, skim feeding, resting, mating, and nursing. These behaviors can occur for periods of an hour or more (NMFS, 2007h). Calves, which spend most of their time at the surface due to their undeveloped diving capabilities, are particularly vulnerable. It is likely that these numbers underestimate the true mortality from ship strikes because experts generally believe that many ship strikes go unreported or undetected (NMFS, 2007h).

The risk of such strikes is high near the Northeast seaboard's busiest ports and shipping lanes, some of which are located near preferred habitat of whales. For example, the main shipping lane to Boston traverses the Stellwagen Bank National Marine Sanctuary, a major feeding and nursery area for several species of baleen whales. Similarly, Cape Cod Canal, another major channel for shipping along the New England coast, provides passage from Buzzards Bay to Cape Cod Bay, an area known for large whale activity (Hoyt, 2001). In southeastern waters, shipping channels associated with Jacksonville and Fernandina, Florida and Brunswick, Georgia bisect the area that contains the highest concentration of whale sightings within right whale critical habitat. These channels and their approaches serve several commercial shipping ports and military bases (NMFS, 2007h).

A number of initiatives have been implemented to reduce potential interactions between marine mammals and ships (NMFS, 2007h). Perhaps the most comprehensive effort focuses on right whales. A mandatory ship reporting system provides information to mariners entering right whale habitat through periodic notices and aerial surveys notify mariners of right whale sighting locations. Other support includes shipping industry liaisons, recovery team recommendations, and ESA section 7 consultation work (NMFS, 2007h). In an effort to direct shipping traffic away from areas of high right whale occurrence, recommended routes were charted in November 2006 for four locations to reduce the likelihood of ship collisions. These locations include Fernandina, Florida; Jacksonville, Florida; Brunswick, Georgia; and Cape Cod Bay, Massachusetts (NOAA, 2008). Additionally, on July 1, 2007, NOAA and the USCG implemented a shift in the Traffic Separation Scheme servicing Boston to reduce the threat of vessel collisions with right whales and other whale species. The realignment is expected to result in a 58 percent reduction in the risk of ship strikes to right whales, and an 81 percent risk reduction in ship strikes of other large whale species occurring in the area (NOAA, 2008). Canada has taken similar measures including designation of conservation areas, implementation of a Vessel Traffic System in the Bay of Fundy similar to NOAA’s EWS, and the movement of shipping lanes away from high densities of right whales (NMFS, 2007h).

Research is also continuing in areas related to whale and ship interactions. Efforts are focused on understanding marine mammal biology and ecology and its implications for conservation and management in this area. Particular projects have focused on understanding behavior around vessels and developing new technologies to improve management of vessel-whale interactions (NMFS, 2007h).

Climate change caused by increasing greenhouse gas concentrations from human activities has the potential to introduce additional pressures on marine mammals. Key changes in the climate may include increased precipitation and ocean temperature, decreased sea ice coverage, and increases and decreases in salinity (NMFS, 2007h). These effects in turn may influence habitats, food webs, and species interactions. Evaluations of the direct effects of climate change on whales are generally confined to cetaceans in the Arctic and Antarctic regions, where the impacts of climate change are expected to be the strongest. The possibility exists that the indirect effects of climate change on prey availability and cetacean habitat will be more widespread, and could affect marine mammals in the AFAST Study Area. For example, climate change could exacerbate existing stresses on fish stocks that are already overfished and indirectly affect prey availability (NMFS, 2007h). Additional effects include increased algal blooms and biotoxins and increased pollutant runoff and chemical contaminants from precipitation (NMFS, 2007h). Habitat shifts are another possible implication of climate change. Walther et al. (2002) examined recent shifts of marine communities in response to rising water temperatures, concluding that most cetaceans will experience roughly poleward shifts in prey distributions (Walther et al., 2002). For some marine mammal species, these small changes may have little material effect, but for species already vulnerable because of severe existing problems, like the North Atlantic right whale, these changes could be significant obstacles to species survival (NMFS, 2007h).

Authorized takes of marine mammal species also include scientific research and subsistence use. Discussion of takes associated with scientific research is included in the section on Seismic Surveys and Scientific Research. The subsistence hunting of marine mammals by Native Americans in U.S. waters generally occurs in the Pacific Ocean. Potential impacts resulting from the proposed activity will be limited to individuals of marine mammal species located off the East Coast and in the Gulf of Mexico, and will not affect Arctic marine mammals. Since the AFAST active sonar activities will not take place in Arctic waters, additional discussion on subsistence use is not warranted.

Acoustic analysis was performed in order to estimate the effects associated with AFAST active sonar activities. Chapter 4 discusses the methodology used to measure these effects in detail. The results of acoustic analysis indicates that 16,520 ESA-listed marine mammals may be exposed to levels of sound likely to result in Level B harassment under the No Action Alternative, 11,493 under Alternative 1, 10,655 under Alternative 2, and 14,559 under Alternative 3. It also indicates that one ESA-listed marine mammals may be exposed to levels of sound likely to result in Level A harassment under the No Action Alternative, and none under Alternative 1, one under Alternative 2, and one under Alternative 3. The exposure estimates for each alternative represents the total number of exposures and not necessarily the number of individuals exposed, as a single individual may be exposed multiple times over the course of a year. The Navy finds that ESA-listed species may experience a cumulative impact from AFAST active sonar activities; however, they are not expected to adversely affect the populations of ESA-listed species. As part of the environmental documentation for this EIS/OEIS, the Navy has entered into early consultation with NMFS in accordance with Section 7 of the ESA. See Section 4.4.10 for additional information.

Acoustic analysis indicates that 1,911, 198 total marine mammals (including ESA-listed species) may be exposed to levels of sound likely to result in Level B harassment under the No Action

Alternative, 1,334,900 under Alternative 1, 1,288,320 under Alternative 2, and 1,702,645 under Alternative 3. Acoustic analysis also indicates that 128 total marine mammals (including ESA-listed species) may be exposed to levels of sound likely to result in Level A harassment under the No Action Alternative, 89 under Alternative 1, 82 under Alternative 2, and 109 under Alternative 3. No mortalities are predicted due to AFAST active sonar activities. The exposure estimates for each alternative represents the total number of exposures and not necessarily the number of individuals exposed, as a single individual may be exposed multiple times over the course of a year. The Navy has determined that AFAST active sonar activities will have a negligible impact on marine mammal species or stock. The Navy has initiated consultation with NMFS in accordance with the MMPA for concurrence. See Section 4.4.10 for additional information.

Section 6.3 discusses other Navy actions where underwater sound is the primary environmental concern. Marine mammal exposures to Level A and Level B sound have been estimated for actions described in the VACAPES, CHPT, JAX/CHASN and USWTR environmental planning documents. In addition, other actions listed in Section 6.3 for which exposures have not been calculated and that also occur within the AFAST Study Area can contribute to the potential for multiple Level A or Level B sound exposures. Thus, marine mammals could experience Level A or Level B sound from multiple actions. Potential cumulative effects include avoidance of a larger area of habitat, or increased stresses from multiple, successive or prolonged behavioral responses.

Marine mammals are also subject to entanglement in expended materials, particularly anything incorporating loops or rings, hooks and lines, or sharp objects. Most documented cases of entanglements occur when whales encounter the vertical lines of fixed fishing gear. Possible expended materials from AFAST active sonar activities include sonobuoys, torpedoes, and ADCs, and EMATTs. It was determined in Chapter 4 that the overall possibility of marine mammals ingesting parachute fabric or becoming entangled in cable assemblies is very remote. Furthermore, it is unlikely that a marine mammal would come into direct contact with a torpedo, torpedo flex hose, ADC, or EMATT.

Since there is no means of predicting where specific AFAST active sonar activities would occur, there is not enough information available to determine potential effects to resident stocks.

6.4.1.5.2 AFAST Incremental Contribution and Cumulative Effects from Other Projects and Activities (Past, Present, and Reasonably Foreseeable Future)

The exposure numbers mentioned above are considered conservative, and the Navy anticipates that any potential adverse effects to marine mammals will be further minimized by the implementation of the mitigation measures identified in Chapter 5. In addition, the Navy has concluded that marine mammals will not be impacted by non-acoustic effects. The Navy is requesting a LOA pursuant to the MMPA, which also requires NMFS to develop the regulations that govern the issuance of an LOA. By issuing the LOA, NMFS would authorize the take of marine mammals incidental to the Navy’s Proposed Action. The Navy is also consulting with NMFS in accordance with Section 7 of the ESA to ensure that AFAST active sonar activities would not jeopardize the continued existence of any endangered or threatened species, or result in the destruction or adverse modification of a critical habitat. This consultation will be complete when NMFS prepares a final BO and issues an incidental take statement. Therefore, while there is the potential for moderate, recoverable cumulative effects to marine mammals under the No Action Alternative, Alternative 1, Alternative 2, or Alternative 3, the combined takes from all Navy sources would be mitigated to insignificance via mitigation measures discussed in Chapter 5, LOA and ESA biological opinion terms and conditions, Navy ICMP conservation initiatives and other protected species research funded by the Navy. These measures would minimize any potential adverse impacts to marine mammals and would avoid any significant or long-term adverse impacts to threatened and endangered species. Furthermore, impacts are expected to be limited to temporary behavioral impacts. Therefore, no significant cumulative impacts are anticipated.

6.4.1.6 Sea Turtles

6.4.1.6.1 AFAST EIS/OEIS Conclusions

Sea turtles experience a number of natural and anthropogenic threats throughout their diverse life history. Natural threats include hurricanes, cold stunning, and biotoxin exposure. Sand accretion and rainfall associated with hurricanes and waves generated from storm surges can damage sea turtle nesting habitat extensively. For example, in 1992, all of the eggs over a 145 km (90 mile) length of coastal Florida were destroyed by storm surges on beaches that were closest to the eye of Hurricane Andrew (Milton et al., 1994). Man-made threats on land include beach erosion, armoring, nourishment, and cleaning; artificial lighting; increased human presence; recreational beach equipment and driving; coastal construction; planting exotic dune and beach vegetation; and poaching. Anthropogenic threats at sea include entanglement in gear of commercial fisheries, ingestion of marine debris, and strikes by vessels.

A large portion of the sea turtle mortalities related to humans comes from commercial fishing. Sea turtles entangled in fishing gear generally experience a reduced ability to feed, dive, surface/breathe, or perform any other behavior essential to survival. They may be more susceptible to boat strikes if forced to remain at the surface, and entangling lines can constrict blood flow. In the AFAST Study Area, commercial fisheries affect in particular loggerhead, leatherback, green, and Kemp's ridley sea turtles. The following paragraphs describe the effects from fisheries to each of these species and efforts NMFS has taken to reduce their mortality in the industry operations (NMFS, 2007h).

Thousands of loggerhead sea turtles interact with commercial fisheries each year. Basin-wide average bycatch rates, extrapolated to account for total longline effort in the Atlantic and Mediterranean, yielded a minimum estimate of over 200,000 loggerheads caught in these waters in 2000. Although not all of these interactions would have been lethal, thousands of potential turtle mortalities may have occurred based on a Hawaii-based study by NMFS suggesting a 27 to 42 percent immediate and delayed post-hooking mortality rate for loggerheads (NMFS-SEFSC, 2001b). Aguilar et al. (1995) estimated that the Spanish swordfish longline fleet, which is only one of the many fleets operating in AFAST Study Area, captures more than 20,000 juvenile loggerheads annually (killing as many as 10,700). Observer records indicate that an estimated

6,900 loggerheads were captured by U.S. fishermen between 1992 and 1998. An estimated 43 of these turtles were dead (NMFS, 2007h).

Loggerheads are also caught in coastal waters of the AFAST Study Area, for example, in pound net gear and trawls in the Mid-Atlantic and Chesapeake Bay; in gillnet fisheries in the Mid-Atlantic, and in Northeast sink gill net fisheries. Annual peaks in loggerhead strandings in the Mid-Atlantic regularly occur in early summer and late fall, coinciding with increased gillnet activity. Observers have documented lethal takes of loggerheads and Kemp's ridleys in these fisheries (TEWG, 2000). Shrimp trawlers, however, represent the most significant source of incidental takes from commercial fisheries, and are believed to be the largest single source of mortality in southeastern U.S. waters. Magnuson et al. (1990) estimated 5,000 to 50,000 loggerheads killed each year by the offshore commercial shrimp fleet in the southeastern Atlantic and Gulf of Mexico.

Of the Atlantic turtle species, leatherbacks may be the most vulnerable to entanglement in fishing gear because of their body type (large size, long pectoral flippers, and lack of a hard shell), their attraction to organisms that collect on buoys and buoy lines at or near the surface, and perhaps their attraction to the lightsticks used to attract target species in longline fisheries. They are also susceptible to entanglement in gillnets (used in various fisheries) and to capture in trawl gear (e.g., shrimp trawls). According to observer records, an estimated 6,363 leatherback sea turtles were caught by the U.S. Atlantic tuna and swordfish longline fisheries between 1992 and 1999, of which 88 were released dead. Since the U.S. fleet accounts for only five to eight percent of the longline vessels in the Atlantic Ocean, the impact from the takes of the other 23 countries actively fishing in the area would likely result in annual take estimates of thousands of leatherbacks over different life stages. Other fisheries that endanger leatherback sea turtles include the trap/pot, blue crab, lobster, stone crab, gillnet, sink net, and pound net fisheries (NMFS, 2007h).

In addition to the natural threats of other sea turtles, green turtles appear susceptible to fibropapillomatosis, an epizootic disease producing lobe-shaped tumors on the soft portion of a turtle's body. Juveniles are most commonly affected. The occurrence of these tumors may impair foraging, breathing, or swimming and lead to death. Sea sampling coverage in the pelagic driftnet, pelagic longline, southeast shrimp trawl, and summer flounder bottom trawl fisheries has recorded takes of green turtles. Strandings of green turtles in Virginia indicate that they may also be susceptible to interactions with the state pound net fishery (NMFS, 2007h).

Takes of Kemp's ridley turtles have been recorded by sea sampling coverage in the Northeast otter trawl fishery, pelagic longline fishery, and southeast shrimp and summer flounder bottom trawl fisheries. Among U.S. commercial fisheries, the southeast shrimp trawl fishery is known to take the highest number of leatherback sea turtles with an estimated 640 leatherback captures annually. Approximately 25 percent (160) of the captured animals die from drowning (Henwood and Stuntz, 1987). Although not the largest known source of anthropogenic mortality, gillnet and crab pot fishing gear has taken Kemp's ridley sea turtles. Of the juveniles caught by fishing, four fishermen caught an estimated four percent in gill nets and 0.2 percent by crab pots. Tag returns for adult turtles indicate that seven percent were caught in gill nets (Marquez et al., 1989).

To address the threats to sea turtles, NMFS has identified ways to reduce mortality in commercial fisheries. For example, the agency has worked with the industry to develop and use turtle excluder devices (TEDs) in trawls to reduce turtle takes. These devices are particularly beneficial to the smaller sea turtle species (NMFS, 2007h). To protect the larger leatherback species, NMFS has established a Leatherback Conservation Zone, which restricts, when necessary, shrimp trawl activities from off the coast of Cape Canaveral, Florida to the Virginia/North Carolina border. NMFS can quickly and temporarily close the area or portions it when high concentrations of leatherbacks are present, to shrimp fishermen who do not use TEDs with an escape opening large enough to exclude leatherbacks. Additional measures include fishery closures during particular seasons and in specified geographic locations, seasonal restrictions on fishing gear, and reporting and monitoring requirements for fisheries such as pound netting. The agency conducts stock assessments and convenes groups to develop and implement take reduction plans. NMFS also conducts outreach efforts to the recreational fishing community (NMFS, 2007h).

All of the turtles species found in the AFAST Study Area are ESA-listed species. As such, the Navy's has initiated early consultation with NMFS in accordance with Section 7 of the ESA. Acoustic analysis for mid- and high-frequency active sonar activities was not performed for sea turtles due to the fact that sea turtles appear to be most sensitive only to low frequencies. Acoustic effects on sea turtles from explosive source sonobuoys (AN/SSQ-110A) were analyzed in Chapter 4. Acoustic analysis indicates that a total of five sea turtle may be exposed to levels of sound likely to result in Level B harassment under the No Action Alternative, 12 under Alternative 1, 10 under Alternative 2, and five under Alternative 3. Acoustic analysis also indicates that one sea turtle may be exposed to levels of sound likely to result in Level A harassment under the No Action Alternative, three under Alternative 1, two under Alternative 2, and two under Alternative 3. Included in the Level A exposure numbers, acoustic analysis indicates that no sea turtles may be exposed to levels of sound likely to result in mortality under all of the Alternatives. The exposure estimates for each alternative represents the total number of exposures and not necessarily the number of individuals exposed, as a single individual may be exposed multiple times over the course of a year. See Section 4.5.2 for additional information.

Estimated sea turtle exposures from explosive source actions described in the VACAPES, CHPT and JAX/CHASN environmental planning documents. Additionally, other actions listed in Section 6.3 could potentially affect sea turtles. Potential cumulative effects include avoidance of a larger area of habitat, or increased stresses from multiple, successive or prolonged behavioral responses.

Similar to marine mammals, sea turtles are subject to entanglement in expended materials, particularly anything incorporating loops or rings, hooks and lines, or sharp objects. Possible expended materials from AFAST active sonar activities include sonobuoys, torpedoes, and ADCs, and EMATTs. However, it was determined in Chapter 4 that the overall possibility of a sea turtle ingesting parachute fabric or becoming entangled in cable assemblies is very remote. Furthermore, it is unlikely that a sea turtle would come into direct contact with a torpedo, torpedo flex hose, ADC, or EMATT. As such, it was determined there would be no significant impact to sea turtles as a result of expended materials during active sonar activities under the No Action Alternative, Alternative 1, Alternative 2, or Alternative 3.

6.4.1.6.2 AFAST Incremental Contribution and Cumulative Effects from Other Projects and Activities (Past, Present, and Reasonably Foreseeable Future)

The Navy has determined that sea turtles may experience a cumulative effect from AFAST active sonar activities; however, they will not likely adversely affect sea turtle populations as the impacts are expected to be limited to temporary behavioral impacts. As mentioned above, the Navy has entered early consultation with NMFS in accordance with Section 7 of the ESA. In addition, sea turtles are more likely to be impacted from interaction with equipment used during fishery practices than from activities conducted during a naval active sonar activity. While the estimates for the incidental catch of sea turtles in longline fisheries vary from year to year, approximately 800 to 3,500 sea turtles in the Atlantic interact with longline fisheries (Dietrick et al., 2007). The highest sea turtle interaction rates are in the Gulf of Mexico through the mid-Atlantic and Grand Banks (Dietrich et al., 2007). It is expected that the mitigation measures identified in Chapter 5 would be implemented to minimize any potential adverse effects to sea turtles. Moreover, the Navy is consulting with NMFS in accordance with Section 7 of the ESA for any potential effects active sonar activities may have on sea turtles. For all Navy actions, there is a potential for moderate, recoverable cumulative effects to sea turtles under the No Action Alternative, Alternative 1, Alternative 2, or Alternative 3. However, the combined takes from all Navy sources would be mitigated through ESA biological opinion terms and conditions, Navy ICMP conservation initiatives discussed in Section 5.5 and other protected species research funded by the Navy. As such, it was determined there would be no significant cumulative impact to sea turtles as a result of expended materials and sound exposure during active sonar activities under the No Action Alternative, Alternative 1, Alternative 2, or Alternative 3.

6.4.1.7 Marine Fish

6.4.1.7.1 AFAST EIS/OEIS Conclusions

Studies have indicated that acoustic communication and orientation of fish may be restricted by sound regimes in their environment. However, most marine fish species are not expected to be able to detect sounds in the mid- and high- frequency range of the operational sonars used in the Proposed Action, and therefore, the sound sources do not have the potential to mask key environmental sounds. The few fish species that have been shown to be able to detect mid-frequencies do not have their best sensitivities in the range of the operational sonars. Additionally, vocal marine fish largely communicate below the range of mid- and high-frequency levels used in the Proposed Action.

Moreover, there is no information available that suggests exposure to non-impulsive acoustic sources results in significant fish mortality on a population level. Mortality has been shown to occur in one species, a hearing specialist; however, the level of mortality was considered insignificant in light of natural daily mortality rates. Experiments have shown that exposure to loud sound can result in significant threshold shifts in certain fish that are classified as hearing specialists (but not those classified as hearing generalists). Threshold shifts are temporary, and it is not evident that they lead to any long-term behavioral disruptions. The data presented in Chapter 4 indicates that there are no long-term negative effects on marine fish from underwater sound associated with sonar activities. Further, while fish may respond behaviorally to mid and high-frequency sources, this behavioral modification is only expected to be brief and not biologically significant.

In regards to the explosive source sonobuoy (AN/SSQ-110A), Chapter 4 discussed that the large variations in the fish population, including numbers, species, sizes, and orientation and range from the detonation point, make it very difficult to accurately predict mortalities at any specific site of detonation. Most fish species experience a large number of natural mortalities especially during early life-stages, and therefore any small level of mortality caused by the AFAST active sonar activities involving the explosive source sonobuoy (AN/SSQ-110A) will most likely be insignificant to the population as a whole.

Therefore, it was determined that there would be no significant impact to fish populations as a result of active sonar activities under the No Action Alternative, Alternative 1, Alternative 2, or Alternative 3.

6.4.1.7.2 AFAST Incremental Contribution and Cumulative Effects from Other Projects and Activities (Past, Present, and Reasonably Foreseeable Future)

The overall effect on fish stocks would be negligible compared to the impact of commercial and recreational fishing in the Study Area. After completion of an active sonar activity, repopulation of an area by fish should take place within a matter of hours. Even for fish that are able to detect mid-frequency sounds, both the fish and vessels are moving, which would mean a minor exposure to the mid-frequency sounds being emitted by the sonar. Also, any exposure to mid-frequency active sonar will only be temporary (i.e., would not occur for long increments of time) and is considered transient in nature. Therefore, the exposure to mid-frequency sounds is transient in nature. Consequently, the exposure would be temporary and not considered significant. As such, no long-term changes to species abundance or diversity, loss or degradation of sensitive habitats, or effects to threatened and endangered species are expected. There is the potential for minor, but recoverable cumulative impacts to marine fish under the No Action Alternative, Alternative 1, Alternative 2, and Alternative 3.

6.4.1.8 Essential Fish Habitat (EFH)

6.4.1.8.1 AFAST EIS/OEIS Conclusions

EFH types include hardbottom, softbottom, estuaries, reefs, wrecks, inshore areas, oyster reefs, and vegetated bottom. Impacts to EFH as pertinent to the area covered by this EIS/OEIS may arise from:

- Fishing gear
- Dredging
- Boat groundings
- Coastal construction
- Oil and hazardous materials

- Exotic species
- Toxic algal blooms
- Storm surges and wind generated waves

Mobile fishing gear such as trawls and fixed fearing gear including gillnets and traps/pots can affect EFH. Trawling changes the benthic habitat through direct contact, alters the food web by taking target and non-target species, and changes the chemistry of the water column (NMFS, 2007h). Mobile gear fisheries that affect EFH include bottom trawling related to foreign fisheries, in state waters, and domestic groundfish fisheries. Fixed gear also impacts the benthic community and EFH through these effects. The fixed fisheries with potential to affect EFH includes trap/pot fisheries for lobster, crab, and shrimp; fixed gear fisheries for American lobster, red crab, Jonah crab, hagfish, and black sea bass; and anchored gillnet fisheries that target monkfish and dogfish (NMFS, 2007h).

Dredging also changes EFH and affects prey on and in marine sediments. Large amounts of sediment may be re-suspended, which can change the chemistry and physical composition of the water column. These actions can cause overall changes to the benthic community if they occur over long periods and widespread areas (NMFS, 2007h).

Like dredging, vessel groundings can directly alter the physical structure of the benthic habitats and cause direct mortality to organisms living on and in the sediments. These effects occur to a site-specific, localized area (NMFS, 2007h). There are no documented effects to EFH from vessel groundings and ecosystem wide effects are not expected from such events.

Development of ports and other infrastructure has occurred throughout the coastal zone along the U.S. Atlantic coast and Gulf of Mexico. These projects also have the potential to affect EFH through the alteration of physical structure, direct mortality to organisms, re-suspension of sediments, chemical and physical modification of the water column, and local changes in community structure (NMFS, 2007h). Similar to vessel groundings, the effects are site-specific and restricted to the local area. Ecosystem wide effects not expected from the construction of ports (NMFS, 2007h).

The use of oil and hazardous materials in the marine environment creates opportunities for spills and pollution to occur. Within the AFAST Study Area, spills range from the release of small amounts of fuel to thousands of gallons of oil. Large spills cause direct mortality to birds, fish, sea turtles, and marine mammals; alter the chemical composition of the water column; and change the structure of the benthic community (NMFS, 2007h). Habitats that may be affected include coastal, inshore, and offshore areas from accidental release by vessel accidents, ruptured pipelines, and oil platform spills. Oil spills may also affect pelagic communities through the formation of surface slicks. Other hazardous pollutants, such as metal contaminants, pesticides and herbicides, and chlorine, can also be found in the water column and persist in the sediments of coastal, inshore, and offshore habitats (NMFS, 2007h).

Exotic species are introduced into the marine environment accidentally and intentionally. These introductions alter the physical and biological characteristics of the ecosystem habitats. Non-native species that have been introduced include finfish, shellfish, plants, and parasites. The issues related to exotics include increased competition, niche overlap, predation on native organisms, decreased genetic integrity, and transmission of disease. There are documented cases where exotic species have pushed native species towards extinction. The scientific and regulatory communities are working to develop ways to combat exotics; methods include producing sterile organisms and securing facilities and infrastructure that has the potential to introduce non-native species (NMFS, 2007h).

Toxic algal blooms have occurred throughout the AFAST Study Area in conjunction with the loading of nutrients into the water column and benthic habitats. These blooms change the physical and chemical composition of the water column and can cause mortality to marine organisms. Toxic algal blooms include events related to toxic microscopic algae and non-toxic seaweeds, which can grow uncontrollably and displace native species, alter habitat suitability, and deplete oxygen levels. Communities generally rebound and are adapted to the intermittent occurrence. If they do not, then the marine food web is affected by adverse effects on eggs, corals, sponges, sea turtles, seabirds, and marine mammals (NMFS, 2007h).

Storm surges and wind generated waves also have the potential to affect EFH. The potential exists for surges and waves to alter the bottom and change the characteristics of the water column (NMFS, 2007h). The effects, however, are not generally extensive and do not extend to the entire ecosystem.

No effects to EFH are anticipated from active sonar since acoustic transmissions are brief in nature. In addition, the explosive source sonobuoy (AN/SSQ-110A) will be detonated within the water column. As such, the explosive force resulting from the detonation would be of sufficient distance from the bottom and will not have the potential to disturb the sea floor. Therefore, there will be no significant effect to EFH from active sonar activities under the No Action Alternative, Alternative 1, Alternative 2, or Alternative 3.

6.4.1.8.2 AFAST Incremental Contribution and Cumulative Effects from Other Projects and Activities (Past, Present, and Reasonably Foreseeable Future)

Since the majority of AFAST active sonar activities are short-term and occur underwater, interaction with EFH during active sonar activities is not expected to result in an a reduction of the quality or quantity of EFH. As discussed in Section 4.6, any impacts would be considered temporary or minimal, and are not considered an adverse impact to EFH. As such, any cumulative impact would only be minor and recoverable. No significant cumulative impacts are anticipated.

6.4.1.9 Sea Birds

6.4.1.9.1 AFAST EIS/OEIS Conclusions

The primary threats to sea birds include commercial fishing and exploitation from hunting sea birds and collecting eggs. Additional considerations include exotic species, marine debris and pollution including underwater sound. The longline fishing industry experiences high incidental catch rates of sea birds because the operations use baited hooks on a main line that remain in the air or near the surface of the water (NMFS, 2001b). The bait attracts birds, which may accidentally get hooked and then drown or entangle as they are dragged underwater. Additionally, personnel on vessels discard fish, scraps, and bait. The availability of these food sources attracts sea birds and in turn, the individuals get hooked or entangled in the main lines (NMFS, 2001b). The majority of research in this area has been conducted in the Pacific because of the concentration of longline operations in Hawaii and Alaska. The Final U.S. National Plan of Action for Reducing the Incidental Catch of Seabirds in Longline Fisheries addresses Atlantic operations including Atlantic tuna, swordfish, sharks, and billfish (NMFS, 2001b). Historically, NMFS observer programs have focused on sea turtles and marine mammals and have only limited data on sea bird by-catch (NMFS, 2001b). Quantitative information is not currently available on the incidental catch of seabirds in fisheries of the U.S. Atlantic coast and Gulf of Mexico.

A number of mitigation measures are under development and have been implemented voluntarily. Such measures include the use of bird-scaring devices and weighted lines, the practice of night setting, and the avoidance of offal (e.g., discarded bait and fish scraps) dumping. Other practices include education and outreach to fishermen and the public and continued research to assess sea bird interactions and appropriate mitigations (NMFS, 2001b).

There is no scientific evidence to suggest birds can hear sounds underwater. Moreover, studies researching the potential effects of underwater sound to diving birds during pile-driving and seismic surveys, determined that airguns did not cause harm. Explosives did result in injury, but only when the seabirds were near the detonation (Turnpenny and Nedwell, 1994). Furthermore, seabirds spend a short period of time underwater, and it is extremely unlikely that the timing of active sonar use would coincide with the dive of a seabird. Therefore, it was determined that there will be no significant impacts to seabirds from active sonar activities under the No Action Alternative, Alternative 1, Alternative 2, or Alternative 3.

In addition, entanglement and the actual drowning of a seabird in a parachute assembly is unlikely, since the parachute would have to land directly on the animal, or a diving seabird would have to be diving exactly underneath the location of the sinking parachute. The potential for a seabird to encounter an expended parachute is extremely low, given the generally low probability of a seabird being in the immediate location of deployment. Therefore, it was determined that there will be no adverse effects to seabirds from entanglement associated with active sonar activities under the No Action Alternative, Alternative 1, Alternative 2, or Alternative 3.

6.4.1.9.2 AFAST Incremental Contribution and Cumulative Effects from Other Projects and Activities (Past, Present, and Reasonably Foreseeable Future)

Other activities previously described in this chapter have the potential to impact sea birds and migratory birds. Since the majority of AFAST active sonar activities are short-term and occur underwater it is expected that only rare, if any, occurrences of an interaction between active sonar activity and diving seabirds could be expected. As such, there is the potential for minor, but recoverable cumulative impacts to seabirds under the No Action Alternative, Alternative 1, Alternative 2, and Alternative 3 when combined with other actions. Impacts would be temporary and localized and would not be considered significant.

6.4.1.10 Marine Invertebrates

6.4.1.10.1 AFAST EIS/OEIS Conclusions

According to the NRC (2003), there is very little information available regarding the hearing capability of marine invertebrates. However, since acoustic transmissions are brief in nature, effects to marine invertebrates from active sonar are not anticipated. In addition, there is a huge variation in marine invertebrates, including numbers, species, sizes, and orientation and range from the detonation point, which makes it very difficult to accurately predict effects at any specific site of detonation from the explosive source sonobuoy (AN/SSQ-110A). Most invertebrates experience large number of natural mortalities especially since they are important foods for fish, reptiles, birds, and mammals. Any level of mortality caused by AFAST active sonar activities involving the explosive source sonobuoy (AN/SSQ-110A) would most likely be insignificant to the population as a whole. In addition the explosions associated with the explosive source sonobuoy (AN/SSQ-110A) will be occurring within the water column. Based on the small net explosive weight (NEW) of the explosive, it is not likely that the pressure wave associated with the detonation will reach the bottom of the ocean, where the majority of invertebrates live. Therefore, it was determined that there will be no adverse effects to marine invertebrates from active sonar activities under the No Action Alternative, Alternative 1, Alternative 2, or Alternative 3.

6.4.1.10.2 AFAST Incremental Contribution and Cumulative Effects from Other Projects and Activities (Past, Present, and Reasonably Foreseeable Future)

Other activities described earlier in chapter 6 which would most likely have the greatest effect on marine invertebrates are dredging, commercial fishing, environmental contamination and biotoxins. AFAST active sonar activities would be relatively isolated due to the large expanses of area between activity locations. As such, there is a potential for minor, but recoverable, cumulative impacts to marine invertebrates under the No Action Alternative, Alternative 1, Alternative 2, and Alternative 3. Impacts would be temporary and localized and would not be considered significant.

6.4.1.11 Marine Plants and Algae

6.4.1.11.1 AFAST EIS/OEIS Conclusions

No effects to marine plants and algae are anticipated from active sonar since plants and algae are acoustically transparent. In addition, the detonation of the explosive source sonobuoy (AN/SSQ-110A) will occur within the water column. *Sargassum* mats are easily identified and will be avoided wherever possible. Therefore, it was determined that there will be no adverse effects to marine plants and algae from active sonar and no adverse effects to marine plants and algae from the explosive source sonobuoy (AN/SSQ-110A) under the No Action Alternative, Alternative 1, Alternative 2, or Alternative 3.

6.4.1.11.2 AFAST Incremental Contribution and Cumulative Effects from Other Projects and Activities (Past, Present, and Reasonably Foreseeable Future)

Other activities described earlier in Chapter 6 which would most likely have the greatest affect on marine invertebrates are dredging, commercial fishing, environmental contamination and biotoxins. AFAST active sonar activities would be relatively isolated due to the large expanses of area in between activity locations. As such, minor, but recoverable cumulative impacts to marine plants and algae could occur under the No Action Alternative, Alternative 1, Alternative 2, or Alternative 3.

6.4.1.12 National Marine Sanctuaries

6.4.1.12.1 AFAST EIS/OEIS Conclusions

Under the No Action Alternative, Alternative 1, Alternative 2, and Alternative 3, the U.S. Navy does not plan to conduct active sonar activities in the Stellwagen Bank, Monitor, Gray's Reef, Flower Garden Banks, and Florida Keys National Marine Sanctuaries and will avoid these sanctuaries by observing a 5 km (2.7 NM) buffer. At all times, the Navy will conduct AFAST active sonar activities in a manner that avoids to the maximum extent practicable any adverse impacts on sanctuary resources. In the event the Navy determines AFAST active sonar activities, due to operational requirements, are likely to destroy, cause the loss of, or injure any sanctuary resource (for Stellwagen Bank National Marine Sanctuary, the threshold is "may" destroy, cause the loss of, or injure), the Navy would first consult with the Director, Office of National Marine Sanctuaries in accordance with 16 U.S.C. 1434(d). Therefore, there would be no significant impact and no significant harm to the Stellwagen Bank, Monitor, Gray's Reef, Flower Garden Banks, and Florida Keys National Marine Sanctuaries under Alternative 1, Alternative 2, or Alternative 3.

6.4.1.12.2 AFAST Incremental Contribution and Cumulative Effects from Other Projects and Activities (Past, Present, and Reasonably Foreseeable Future)

The Navy concludes that AFAST active sonar activities would not significantly impact any NMS in the operating areas and are not likely to destroy or cause the loss of resources related to the marine sanctuary. Therefore, it is determined that there is a potential for minor, but recoverable, cumulative effects to the NMS under the No Action Alternative, Alternative 1, Alternative 2, and Alternative 3. The impacts would be temporary and localized and would not be significant.

6.4.1.13 Airspace Management

6.4.1.13.1 AFAST EIS/OEIS Conclusions

Under the No Action Alternative, Alternative 1, Alternative 2, and Alternative 3, there will be no change to existing airspace configuration and scheduling of airspace and Notices to Airmen (NOTAMs) will be completed prior to the activity to ensure aircraft and pilot safety. Therefore, it was determined that there will be no effect to airspace management under the No-action Alternative, Alternative 1, Alternative 2, or Alternative 3.

6.4.1.13.2 AFAST Incremental Contribution and Cumulative Effects from Other Projects and Activities (Past, Present, and Reasonably Foreseeable Future)

AFAST active sonar activities will occur in special use Warning Areas, which are plotted on aeronautical charts so all pilots are aware of their location and the potential for military flight training in the respective airspace.

The airspace between and adjacent to the Warning Areas is designated as an Air Traffic Control Assigned Airspace (ATCAA). The Federal Aviation Administration (FAA) ARTCC's are responsible for air traffic flow control or management within this airspace transition. There are currently 22 ARTCCs in the United States (FAA, 2007). Within the AFAST Study Area, ARTCCs are located in New Hampshire, Virginia, and Florida (FAA, 2007). As stated previously, there will be no changes to existing airspace configuration or the scheduling of airspace as a result of AFAST active sonar activities. The Fleet Air Control Surveillance Facility (FACSFAC) is responsible for scheduling, monitoring, and controlling air traffic for the airspace within the Warning Areas. FACSFAC Pensacola is responsible for coordinating naval airspace and requests by the 46th Test Wing at Eglin AFB, Florida.

A NOTAM will be completed prior to AFAST training that involves aircraft maneuvers associated with active sonar activities and sonobuoy drops, as well as flights of helicopters dipping the AN/AQS-22 (ALFS) sonar. The release of NOTAMs ensures aircraft and pilot safety. Furthermore, the proper coordination and scheduling with the FAA and respective FACSFAC on all matters affecting airspace significantly reduces or eliminates the possibility of indirect or cumulative impacts on civilian and other military aviation and airspace use. No cumulative impacts to airspace management are anticipated.

6.4.1.14 Energy (Water, Wind, Oil and Gas)

6.4.1.14.1 AFAST EIS/OEIS Conclusions

There are currently no wind farms or active gas or oil exploration sites along the East Coast. However, there are proposals which have been filed with federal regulators as discussed in Section 6.3.3 involving offshore wind energy and ocean current energy along the East Coast. In addition, there are no existing or proposed water energy developments in the Gulf of Mexico. While there are no existing wind farms in the Gulf of Mexico proposals to construct wind farms in the Gulf of Mexico do exist as discussed in section 6.3.3.4 .

Based on the earlier discussion in Chapter 6 on these specific alternative energy proposals and oil and gas exploration, there will be no effect to water energy development, wind farms, or gas and oil exploration from active sonar activities off the southeastern or northeastern United States under the No Action Alternative, Alternative 1, Alternative 2, or Alternative 3. Moreover, there will be no effect to water energy development or wind farms from active sonar activities in the Gulf of Mexico under the No Action Alternative, Alternative 1, Alternative 2, or Alternative 3.

Oil and gas drilling is occurring in non-territorial portions of the eastern Gulf of Mexico, and within the territorial and non-territorial portions of the western Gulf of Mexico. The proposed AFAST active sonar activities do not include any increases in tempo over past activities or any changes in locations and there were no documented significant effects to oil and gas drilling platforms during past active sonar activities. Moreover, there will be no significant effect to oil and gas drilling from active sonar activities under the No Action Alternative, Alternative 1, Alternative 2, or Alternative 3.

6.4.1.14.2 AFAST Incremental Contribution and Cumulative Effects from Other Projects and Activities (Past, Present, and Reasonably Foreseeable Future)

The only potential for incremental cumulative impacts is to gas and oil exploration in the Gulf of Mexico. However, the Navy would not approach energy facilities or energy vessels. Therefore, cumulative impacts due to the implementation of Alternative 1, Alternative 2, Alternative 3, or the No Action Alternative and the activities mentioned previously in Chapter 6 would be minor and recoverable. Therefore, the No Action Alternative, Alternative 1, Alternative 2, and Alternative 3 will not result in any significant incremental cumulative impacts with regard to oil and gas exploration in the Gulf of Mexico and only minor, but recoverable, cumulative impacts are anticipated.

6.4.1.15 Recreational Boating

6.4.1.15.1 AFAST EIS/OEIS Conclusions

Potential effects to recreational boating would most likely come from interactions with military vessels. However, most military actions would occur during weekdays, whereas most recreational boating occurs during the weekend. In addition, the Navy does not routinely close areas off to the public, nor would the Navy conduct active sonar activities in the vicinity of recreational boats. Therefore, there is a very low probability of an interaction. As such, as presented in the Chapter 4 analysis, there would be no effects to recreational boating from Alternative 1, Alternative 2, Alternative 3, or the No Action Alternative.

6.4.1.15.2 AFAST Incremental Contribution and Cumulative Effects from Other Projects and Activities (Past, Present, and Reasonably Foreseeable Future)

Due to the fact that the activities would be very short in duration and interaction with recreational boaters is unlikely, cumulative impacts due to the implementation of the No Action Alternative, Alternative 1, Alternative 2, or Alternative 3 with other activities described in this chapter would be minor and short term. No significant cumulative impacts to recreational boating would occur.

6.4.1.16 Commercial and Recreational Fishing

6.4.1.16.1 AFAST EIS/OEIS Conclusions

Potential effects to commercial and recreational fishing would most likely come from interactions with military vessels. However, the majority of commercial fish landings by weight and by value in the southeastern and northeastern Atlantic coast occur in state waters, which is also the primary location for recreational fishing activities. In the Gulf of Mexico, the majority of fishing takes place in federal waters on artificial reefs and hotspots such as canyons and humps.

The Navy does not routinely close areas off to the public, nor would the Navy conduct active sonar activities within the vicinity of fishing vessels. Therefore, there is a very low probability of an interaction. As presented in the Chapter 4 analysis, there would be no significant impacts to commercial and recreational fishing from Alternative 1, Alternative 2, Alternative 3, or the No Action Alternative.

6.4.1.16.2 AFAST Incremental Contribution and Cumulative Effects from Other Projects and Activities (Past, Present, and Reasonably Foreseeable Future)

Due to the fact that active sonar activities would be very short in duration and interaction with commercial and recreational fishing vessels is unlikely, cumulative impacts due to the implementation of the No Action Alternative, Alternative 1, Alternative 2, or Alternative 3 with other activities described in this chapter would most likely be minor, temporary, and localized. Therefore, the proposed action will not result in any significant incremental cumulative impacts with regard to commercial and recreational fishing.

6.4.1.17 Commercial Shipping

6.4.1.17.1 AFAST EIS/OEIS Conclusions

Potential effects to commercial shipping vessels would most likely come from interactions or delays associated with military vessels along the shipping routes. Shipping routes exist throughout the nearshore and offshore waters of the Study Area. However, the ocean area for active sonar activities by the Navy is significantly larger than the area encompassed by shipping routes. Moreover, there have been no documented significant effects to commercial shipping from previous active sonar activities, and the Navy will avoid shipping vessels that transit through the active sonar area. Therefore, there is a very low probability of an interaction. As presented in the Chapter 4 analysis, there would be no significant impacts to commercial shipping from Alternative 1, Alternative 2, Alternative 3, or the No Action Alternative.

6.4.1.17.2 AFAST Incremental Contribution and Cumulative Effects from Other Projects and Activities (Past, Present, and Reasonably Foreseeable Future)

Due to the fact that vessel transits associated with active sonar activities would be very short in duration, interaction with commercial shipping vessels is unlikely. Cumulative impacts due to the implementation of the No Action Alternative, Alternative 1, Alternative 2, or Alternative 3 with other activities described in this chapter would most likely minor, temporary and localized. Therefore, the proposed action will not result in any significant incremental cumulative impacts with regard to commercial shipping.

6.4.1.18 Scuba Diving

6.4.1.18.1 AFAST EIS/OEIS Conclusions

Recreational diving activities typically occur at known diving sites. The Professional Association of Diving Instructors (PADI) recommends that certified scuba divers limit their dive depths to 12 m (40 ft), and certified open-water divers limit their dives to 18 m (60 ft). While more experienced divers are generally limited to 30 m (100 ft), in general, no recreational diver should exceed 40 m (130 ft) (PADI, 2006). Therefore, the likelihood of affecting divers will decrease inversely in proportion to water depth. With the exception of MIW Independent ULT, Object Detection/Navigational Sonar ULT, and RDT&E activities, all active sonar activities occur in water depths greater than 30 m (100 ft). Moreover, the active sonar activities conducted in water depths less than 30 m (100 ft) would be very short duration, generally lasting from 1 to 6 hours. As such, as presented in the Chapter 4 analysis, there would be no significant effects to scuba diving from Alternative 1, Alternative 2, Alternative 3, or the No Action Alternative.

6.4.1.18.2 AFAST Incremental Contribution and Cumulative Effects from Other Projects and Activities (Past, Present, and Reasonably Foreseeable Future)

Due to the fact that the activities would be very short in duration, cumulative impacts associated with the implementation of the No Action Alternative, Alternative 1, Alternative 2, or Alternative 3 and military activities described in this chapter would be minor, temporary, and localized. Therefore, the proposed action will not result in any significant incremental cumulative impacts with regard to recreational diving

6.4.1.19 Marine Mammal Watching

6.4.1.19.1 AFAST EIS/OEIS Conclusions

Potential effects to marine mammal watching would come from the closure of areas for military operations. However, marine mammal watching occurs within a few miles of shore and rarely in federal waters. Tours in the southeast typically last from one to two hours in such hotspots for dolphin watching as the Virginia Beach, Virginia; Nags Head, North Carolina; and Hilton Head Island, South Carolina. Tours in the northeast typically range from three to six hours in length, with an average duration of three and one-half to four hours (Whale and Dolphin Conservation Society [WDCS], 2007). Within the Gulf of Mexico, tours generally last from one and a quarter to three and one-half hours, with average trip durations of two hours. Given the short duration of marine mammal excursions and the fact that most trips occur close to shore, the potential for effects to the industry will be low. As such, it was determined in the Chapter 4 analyses that there would be no significant effect to marine mammal watching from Alternative 1, Alternative 2, Alternative 3, or the No Action Alternative.

6.4.1.19.2 AFAST Incremental Contribution and Cumulative Effects from Other Projects and Activities (Past, Present, and Reasonably Foreseeable Future)

Due to the fact that the activities would be very short in duration, cumulative impacts associated with the implementation of the No Action Alternative, Alternative 1, Alternative 2, or Alternative 3 and military activities described in this chapter would be minor and temporary. Therefore, the proposed action will not result in any significant incremental cumulative impacts with regard to marine mammal watching.

6.4.1.20 Cultural Resources at Sea

6.4.1.20.1 AFAST EIS/OEIS Conclusions

As stated in Chapter 4, known shipwrecks are located within and adjacent to the OPAREAs in the AFAST Study Area. Potential effects to cultural resources at sea would come from physical disturbance, but as stated previously, the small size and low density of expended materials will not cause effects to the sediment stability on the ocean bottom. Many details, including latitudes and longitudes of submerged wrecks and obstruction in coastal waters of the United States are cataloged in the Automated Wreck and Obstruction Information System. The Navy will avoid all known cultural resources and would consult with the applicable agencies, including the State Historic Preservation Officer if effects to cultural resources are anticipated, as required by law. Therefore, it was determined that there will be no significant effects to cultural resources from active sonar activities under the No Action Alternative, Alternative 1, Alternative 2, or Alternative 3.

6.4.1.20.2 AFAST Incremental Contribution and Cumulative Effects from Other Projects and Activities (Past, Present, and Reasonably Foreseeable Future)

Most past, present, and reasonably foreseeable future ocean activities such as commercial ship traffic, fishing, energy exploration, or scientific research, would not substantially affect underwater cultural resources. This is most likely due to lack of physical contact with shipwrecks since their locations are cataloged. Moreover, any activities with the potential for significant impacts on cultural resources will require Section 106 consultation, and would be mitigated as required by law. Where avoidance was practiced, no cumulative impact would result since there would be no contact with the cultural resource. Where cultural resources could not be avoided, Section 106 consultation would mitigate any potential adverse affects to the cultural resources. Therefore, there is the potential for minor, but recoverable cumulative impacts to cultural resources under the No Action Alternative, Alternative 1, Alternative 2, or Alternative 3.

6.4.1.21 Environmental Justice

6.4.1.21.1 AFAST EIS/OEIS Conclusions

As discussed previously, the active sonar activities that are described in this EIS/OEIS are not new and do not involve significant changes in systems, tempo, or intensity from past events. Moreover, there will be no significant effects to geology, water quality, marine habitat, airspace management, cultural resources, or socioeconomics within the AFAST Study Area under the No Action Alternative, Alternative 1, Alternative 2, or Alternative 3. As such, implementation of the proposed action will not pose disproportionate high or adverse effects to minority or low-income populations, or environmental health and safety risks to children.

6.4.1.21.2 AFAST Incremental Contribution and Cumulative Effects from Other Projects and Activities (Past, Present, and Reasonably Foreseeable Future)

Since the proposed action will not pose disproportionate high or adverse effects to minority or low-income populations, or environmental health and safety risks to children, the proposed action will not result in any cumulative impacts.

6.5 ASSESSING INDIVIDUAL PAST, PRESENT, AND FUTURE IMPACTS

In this chapter, past and present actions, as well as reasonably foreseeable future actions, have been identified. A value of "NE" through "***" was assigned to each action based on its potential to cause an adverse effect to a specific resource area. An example of each value is as follows:

- A "NE" value would be given to an action that has no adverse effects to a particular resource.
- A "*" would be given to an action that has the potential for minor, but recoverable, adverse effects to a particular resource. Examples include a negligible or less than significant effect to a resource.
- A "**" would be given to an action that has the potential for moderate, but recoverable, adverse effects to a particular resource. Examples include a measurable effect to a resource, but an effect that would be recoverable.
- A "***" would be given to an action that has the potential for major, non-recoverable, adverse effects to a particular resource. Examples include a significant effect to a resource, including effects that are not recoverable.

Once a value was assigned to each resource for an individual action, an assessment was conducted to determine whether there would be cumulative impacts to the resource area in relation to the Proposed Action. Cumulative impacts were considered likely to occur for the following actions:

- Actions occurring at the same or overlapping areas at the same or similar time.
- Actions occurring in the vicinity at the same or similar time.
- Actions occurring at the same or overlapping areas at some other time.

The same valuation process was used to determine the overall cumulative impact to a resource. It is important to note that even if a resource was given a value of "**" or "***" for an individual action, it does not automatically generate a cumulative impact of "**" or "***." This is due to difference in space and time from other actions or the resource that is potentially affected. For instance, as discussed in Chapter 1, regulatory permits can be granted for certain actions that involve the likely "taking" of protected species, such as marine mammals, sea turtles, or migratory birds. Even though these individual effects would be considered moderate to severe (depending on the action and species affected), regulations are in place to ensure the continued survival of the respective species. Moreover, the implementation of mitigation and mitigation measures for individual actions has the potential to further reduce the cumulative impact.

Table 6-21 summarizes the results of the environmental analysis for each resource area identified previously in this EIS/OEIS that could potentially be affected by the Proposed Action; other past, present, and reasonably expected future actions potentially affecting the same resources; and the magnitude of each individual action.

Table 6-21. Summary of Cumulative Impacts in the Study Area

		Sediment Quality	Marine Debris (Marine Habitat)	Water Quality	Sound in the Environment	Marine Mammals	Sea Turtles	Marine Fish	Essential Fish Habitat	Sea Birds	Marine Invertebrates	Marine Plants and Algae	National Marine Sanctuaries	Airspace Management	Energy Exploration and Offshore Drilling	Recreational Boating	Commercial and Recreational Fishing	Commercial Shipping	SCUBA Diving	Marine Mammal Watching	Cultural Resources	Environmental Justice
Past and Present Actions	Military Operations	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	NE
	MMS: Oil and Gas	**	*	**	*	**	**	*	*	**	*	*	*	NE	---	NE	NE	NE	NE	NE	*	NE
	State Oil and Gas	**	*	**	*	**	**	*	*	**	*	*	*	NE	---	NE	NE	NE	NE	NE	*	NE
	Dredging	**	**	**	*	NE	**	**	**	NE	**	**	**	NE	NE	NE	NE	NE	NE	NE	*	NE
	Commercial and Recreational Fishing	*	**	NE	*	**	**	**	**	**	**	NE	**	NE	NE	NE	---	NE	NE	NE	*	NE
	Maritime Traffic	*	*	*	*	**	*	NE	NE	NE	NE	NE	*	NE	NE	---	NE	---	NE	NE	*	NE
	Scientific Research	NE	*	NE	NE	*	*	*	*	*	*	*	*	NE	**	NE	**	NE	NE	NE	NE	NE
	Debris	---	--	*	NE	**	**	**	**	**	**	NE	*	NE	NE	*	*	*	*	NE	*	NE
	Environmental Contamination and Biotoxins	---	--	**	NE	**	**	**	**	**	**	**	**	NE	NE	NE	**	NE	NE	NE	NE	NE
	Marine Ecotourism	NE	*	*	*	*	*	NE	NE	NE	NE	NE	*	NE	NE	---	NE	NE	---	---	NE	NE
Future Actions	Military Operations	*	*	*	*	*	*	*	*	*	*	*	*	*	NE	*	*	*	*	*	*	NE
	NASA	NE	*	NE	*	NE	NE	NE	NE	*	NE	NE	NE	*	NE	NE	NE	NE	NE	NE	NE	NE
	Offshore LNG	*	**	*	*	*	*	*	*	*	*	*	*	NE	NE	NE	NE	NE	NE	NE	*	NE
	Offshore Windfarms	*	*	**	*	*	*	*	*	**	*	*	*	NE	NE	NE	NE	NE	NE	NE	*	NE
AFAST Proposed Action		*	*	*	*	**	**	*	*	NE	NE	NE	NE	NE	*	NE	*	*	NE	*	*	NE
Cumulative Impacts		*	*	*	*	**	**	*	*	*	*	*	*	NE	*	*	*	*	*	*	*	NE

NE = No adverse effects; * = Potential for minor, but recoverable, adverse effects; ** = Potential for moderate, but recoverable, adverse effects; *** = Potential for major, non-recoverable, adverse effects

This page is intentionally blank.

7. LIST OF PREPARERS

This Atlantic Fleet Active Sonar Environmental Impact Statement/Overseas Environmental Impact Statement was prepared by the Navy with support from Science Applications International Corporation. A list of key preparation and review personnel is included.

The Navy Technical Representative for this document is:

Sarah Kotecki, Environmental Planner, P.E.
Naval Facilities Engineering Command, Atlantic
Code EV22
6506 Hampton Boulevard
Norfolk, VA 23508

Key personnel included the following:

United States Fleet Forces Command
1562 Mitscher Avenue
Norfolk, VA 23551

Name/Title	Project Role	Qualifications
Jene Nissen Environmental Program Acoustic Analyst M.S. Applied Engineering B.S. Electrical Engineering	AFAST Program Manager; Navy Technical Reviewer	22 years Naval operational experience; 2 years NEPA
CDR Dominick Yacono Staff Attorney J.D. Ohio State University M. Labor and Industrial Relations B.A. Economics, International Studies, and History	Legal Reviewer	19 years Legal experience; 8 years NEPA

Naval Facilities Engineering Command, Atlantic
6506 Hampton Boulevard
Norfolk, VA 23508

Name/Title	Project Role	Qualifications
Joel Bell Marine Resource Specialist M.E.M., Coastal Environmental Management B.S., Marine Science	Navy Technical Reviewer	9 years NEPA and protected species compliance
Keleigh Biggins Assistant Counsel J.D. Southern Illinois University B.A. Political Science	Navy Legal Reviewer	9 years Legal experience; 1 year NEPA
Keith Jenkins Marine Resource Specialist M.S. Fisheries Oceanography B.S. Marine Biology	Navy Technical Reviewer	12 years NEPA and marine science
Anurag Kumar Marine Resource Specialist M.S. Marine Science B.S. Biology-Ecology	Navy Technical Reviewer	9 years NEPA and marine science
Mike Schwinn Natural Resource Specialist M.S. Biology B.S. Zoology	Navy Technical Reviewer	18 years NEPA, wildlife biology, and aquatic ecology
Mandy Shoemaker Marine Resource Specialist M.E.M. Coastal Environmental Management B.S. Marine Biology	Navy Technical Reviewer	5 years NEPA and marine science
Todd Williamson Natural Resource Specialist B.S. Biology	Navy Technical Reviewer	1 year NEPA

Science Applications International Corporation

1140 Eglin Parkway
Shalimar, FL 32579

Name/Title	Project Role	Subject Area	Qualifications
Sherri Baker-Littman Marine Archaeologist & Geologist M.Sc. Geology & Geophysics B.A. Anthropology	Author	Affected Environment	4 years environmental science; 19 years archaeology; 9 years geology
Brett Beedles Environmental Acoustic Analyst; Navy NEPA Operations Specialist	Author	Purpose and Need; Alternatives, Underwater Sound; Cumulative Impacts	24 years acoustic analysis/sonar operations
Amanda Boes Environmental Scientist B.S. Environmental Science	Author	Environmental Consequences; Cumulative Impacts	2 year environmental science
Hilary Brich Technical Editor M.A. Philosophy	Editing Team		14 years technical writing and editing
William Brown GIS Analyst/Senior Environmental Engineer M.S. Civil and Environmental Engineering B.S. Civil Engineering	GIS Analyst		15 years GIS, computer modeling, statistical analysis
Chrystal Everson Environmental Scientist M.S. Environmental and Occupational Health B.S. Environmental and Occupational Health	Deputy Project Manager; Author	Environmental Consequences; Cumulative Impacts	9 years environmental science
Janice Fries NEPA Specialist B.S. Biology and Chemistry	Author	Cumulative Impacts	1 year environmental science
Sarah Hagedorn Marine NEPA Specialist M. Environmental Management B.S. Biology	Author	Affected Environment; Cetacean Stranding Report	5 years environmental science
Jenn Latusek NEPA Specialist M. Environmental Management B.S. Marine Biology	Author; Public Affairs Liaison	Public Scoping; Affected Environment; Environmental Consequences; Cumulative Impacts	5 years environmental science
Brent McBroom GIS Analyst	GIS Analyst; Figure Development		12 years GIS

Name/Title	Project Role	Subject Area	Qualifications
Jamie McKee Marine Scientist B.S. Marine Biology	Author; Technical Reviewer	Affected Environment and Environmental Consequences	21 years environmental science
Kimberly McNulty Technical Editor B.A. Communications Arts	Editing Team		17 years technical editing and document production
Diana O'Steen Document Production	Document Production		18 years document management
Russell Piovesan NEPA Specialist M.S. Environmental Management B.S. Biology	Project Manager; Technical Lead; Author	Purpose and Need; Alternatives; Underwater Sound; Cumulative Impacts	17 years environmental science
Jennifer Poirier Environmental Scientist B.S. Environmental Science	Author	Coastal Zone Consistency Determinations; Coastal Zone Negative Determinations	5 years environmental science
Sherry Poucher Environmental Scientist M.S. Natural Resources	Author	Water Quality; Aquatic Toxicology	26 years environmental science
Andy Rogers Sr. Mathematician PhD Marine Estuarine Environmental Science M.S. Marine Estuarine Environmental Science B.A. Speech	Author	Underwater Sound and Acoustics	6 years underwater sound; 16 years GIS tool development
Pamela Safford Economist M.A. Applied Economics B.S. Business Administration	Author	Socioeconomics	3 years socioeconomics
Angela Toole Technical Editor B.A. Journalism/Advertising	Editing Team		26 years editing and document production
Jecely Torres Ramos Environmental Engineer B.S. Civil Engineering	Author	Cumulative Impacts	2 years environmental engineering
Tara Utsey Technical Editor B.A. Liberal Arts	Editing Team		14 years editing and document production

KATZ & Associates
4250 Executive Square, Suite 670
San Diego, CA 92037

Name/Title	Project Role	Qualifications
Karen Snyder B.S. Journalism and Public Relations	Public Outreach and Involvement	22 years public outreach experience
Allison Turner M. Environmental Science and Management B.A. Social Science with Environmental Emphasis	Public Outreach and Involvement	10 years public outreach experience

This page is intentionally blank.

8. LITERATURE CITED

Abend, A. G., and T. D. Smith, 1999. Review of distribution of the long-finned pilot whale (*Globicephala melas*) in the *North Atlantic and Mediterranean*. NOAA Technical Memorandum NMFS-NE-117:1-22.

Aburto, A., D. J. Rountry, and J. L. Danzer, 1997. *Behavioral response of blue whales to active signals*. Technical Report 1746. San Diego, California: Naval Command, Control and Ocean Surveillance Center, RDT&E Division.

Acevedo-Gutiérrez, A., and S. C. Stienessen, 2004. Bottlenose dolphins (*Tursiops truncatus*) increase number of whistles when feeding. *Aquatic Mammals*, Vol 3, No 3, pp 357–362.

Adams, L. D., and P. E. Rosel, 2006. Population differentiation of the Atlantic spotted dolphin (*Stenella frontalis*) in the western North Atlantic, including the Gulf of Mexico. *Marine Biology*, Vol 148, pp 671–681.

Adler, E., and Jeftic, L., 2006. Marine Litter: A Global Challenge. The 1st NOWPAP Workshop on Marine Litter United Nations Environment Program (UNEP). Retrieved from http://www.unep.org/regionalseas/ marinelitter/publications/workshops/nowpap/004.asp, on 9 January 2008.

Advanced Research Projects Agency (ARPA), 1995. Final environmental impact statement for the *Kauai Acoustic Thermometry of Ocean Climate project and its associated marine mammal research program: Vol I and II.* Prepared for the Office of Conservation and Environmental Affairs, Honolulu, Hawaii by the Advanced Research Projects Agency and the National Oceanic and Atmospheric Administration (NOAA).

Advisory Committee on Acoustic Impacts on Marine Mammals, 2006. *Report to the U.S. Marine Mammal Commission*. Marine Mammal Commission; Bethesda, Maryland.

AES Sparrows Point, 2007. *AES Sparrows Point – Project Overview*. Retrieved from http://www. aessparrowspointlng.com/ sparrowspoint.asp#anchor1 on 18 October 2007.

Agler, B. A., R. L. Schooley, S. E. Frohock, S.K. Katona, and I. E. Seipt, 1993. Reproduction of photographically identified fin whales, *Balaenoptera physalus*, from the Gulf of Maine. *Journal of Mammalogy*, Vol 74, No 3, pp 577–587.

Aguilar de Soto, N., M. P. Johnson, and P. T. Madsen, 2005. Deep foraging of pilot and beaked whales: DTag results. *European Research on Cetaceans,* Vol 19, pp 13–14.

Aguilar, A., 2002. Fin whale, *Balaenoptera physalus*. in *Encyclopedia of marine mammals,* Perrin, W.F., B. Würsig, and J.G.M. Thewissen, eds. Academic Press: San Diego, California. pp 435–438.

Aguilar, R., J. Mas, and X. Pastor, 1995. *Impact of Spanish swordfish longline fisheries on the loggerhead sea turtle,* Caretta caretta, *population in the western Mediterranean*. 12th edition. p 1.

Allen, B. M., D. E. Pitassy, J. G. Mead, and C. W. Potter, 2005. Beaked whale identification reference on the web: A tool for stranding responders, in *Abstracts, Sixteenth Biennial Conference on the Biology of Marine Mammals*. 12–16 December 2005. San Diego, California. p 11.

Allen, G. M., 1930. The walrus in New England. *Journal of Mammalogy,* Vol 11, No 2, pp 139–145.

Alsop, F. J., 2001. *Birds of North America Eastern Region*. D.K. Publishing, Inc.: New York.

Amano, M., A. Hayano, and N. Miyazaki, 2002. Geographic variation in the skull of the ringed seal, *Pusa hispida*. *Journal of Mammalogy,* Vol 83, No 2, pp 370–380.

Amano, M., and M. Yoshioka, 2003. Sperm whale diving behavior monitored using a suction-cup-attached TDR tag. *Marine Ecology Progress Series*, Vol 258, pp 291–295.

Amaral, K., K. Fullard, G. Early, and B. Amos, 2001. Social and stock structure of Atlantic white-sided dolphins, *Lagenorhynchus acutus*, in *Abstracts, Southeast and Mid-Atlantic Marine Mammal Symposium*. 30 March–1 April 2001. Beaufort, North Carolina. p 7.

American Ornithologists' Union, 1957. *Checklist of North American Birds*, 5th ed. American Ornithologists' Union: Baltimore, Maryland.

American Society of Limnology and Oceanography, Inc, 1988. The concept of "primary production" in aquatic ecology. *Limnology Oceanography*, Vol 33, No 5, pp 1215–1216.

American Sportfishing Association (ASA), 2007a. Sales and Economic Trends: 2001 State by State Economic Impacts—Saltwater by State. Retrieved from http://www.asafishing.org/asa/statistics/saleco_trends/ state_reports_saltwater.html, on 26 June 2007.

American Sportfishing Association (ASA), 2007b. Sportfishing in America. Retrieved from http://www.asafishing.org/asa/images/statistics/participation/sportfishing_america/fish_eco_impact.pdf, on 26 June 2007.

Amoser, S., and F. Ladich, 2003. Diversity in noise-induced temporary hearing loss in otophysine fishes. *Journal of the Acoustical Society of America*, Vol. 113, pp 2170–2179.

Amoser, S., and F. Ladich, 2005. Are hearing sensitivities of freshwater fish adapted to the ambient noise in their habitats? *Journal of Experimental Biology*, Vol 208, pp 3533–3542.

Andersen, S., 1970. Auditory sensitivity of the harbour porpoise *Phocoena phocoena*. *Investigations on Cetacea*, Vol 2, pp 255–259.

Anderson, R. C., 2005. Observations of cetaceans in the Maldives, 1990–2002. *Journal of Cetacean Research and Management*, Vol 7, No 2, pp 119–135.

Andrews, J. C., and P. R. Mott, 1967. Gray seals at Nantucket, Massachusetts. F.A. Abreu-Grobois, R. Briseño, R. Márquez, and L. Sarti, eds. p 149, Vol 48, pp 657–658.

Andrews, J., and N. Jelley, 2007. Hydropower, tidal power, and wave power. *Energy Science: Principles Technology and Impacts*. Oxford University Press.

Angliss, R. P., and D. P. DeMaster, 1998. Differentiating serious and non-serious injury of marine mammals taken incidental to commercial fishing operations: *Report of the Serious Injury Workshop*, 1–2 April 1997, Silver Spring , Maryland. U.S. Department of Commerce. NOAA Technical Memorandum NMFS-OPR-13. p 48.

Angliss, R. P. and R. B. Outlaw, 2008. *Final Alaska Marine Mammal Stock Assessments 2007*. NOAA Technical Memorandum NMFS-AFSC-180:1–253.

Anonymous, 2004. Right whale is spotted in Gulf of Mexico. *News Herald*, 6 July, 2004.

Anonymous, 2006. Accidental tourist: Manatee cruises Hudson River. Retrieved from http://www.cnn.com/2006/US/08/07/manatee.hudson.river.ap/index.html on 15 August 2006.

Archer, F. I., II, and W. F. Perrin, 1999. *Stenella coeruleoalba*. *Mammalian Species*, Vol 603, pp 1–9.

Asselin, S., M. O. Hammill, and C. Barrette, 1993. Underwater vocalizations of ice breeding grey seals. *Canadian Journal of Zoology*, Vol 71, pp 2211–2219.

Astrup, J., 1999. Ultrasound detection in fish–a parallel to the sonar-mediated detection of bats by ultrasound-sensitive insects. *Comparative Biochemistry and Physiology*, Part A, Vol 124, pp 19–27.

Astrup, J., and B. Møhl, 1993. Detection of intense ultrasound by the cod (*Gadus morhua*). *Journal of Experimental Biology*, Vol 182, pp 71–80.

Au, D. W. K., and W. L. Perryman, 1985. Dolphin habitats in the eastern tropical Pacific. *Fishery Bulletin,* Vol 83, No 4, pp 623–643.

Au, W. W. L, 1993. *The sonar of dolphins*.Springer–Verlag: New York.

Au, W. W. L., and D. A. Pawloski, 1989. A Comparison of Signal Detection between an echolocating dolphin and an optimal receiver. *Journal of Comparative Physiology,* Vol 164, pp 451–458.

Au, W. W. L., A. A. Pack, M. O. Lammers, L. M. Herman, M. H. Deakos, and K. Andrews, 2006. Acoustic properties of humpback whale songs. *Journal of the Acoustical Society of America,* Vol 120, No 2, pp 103–1110.

Au, W. W. L., A. A. Pack, M. O. Lammers, L. M. Herman, M. H. Deakos, and K. Andrews, 2006. Acoustic properties of humpback whale songs. *Journal of the Acoustical Society of America*, Vol 120, No 2, pp 1103–1110.

Au, W. W. L., and D. L. Herzing, 2003. Echolocation signals of wild Atlantic spotted dolphin (*Stenella frontalis*). *Journal of the Acoustical Society of America*, Vol 113, No 1, p 598–604.

Au, W., J. Darling, and K. Andrews, 2001. High-frequency harmonics and source level of humpback whale songs. *Journal of the Acoustical Society of America*, Vol 110, No 5, p 2770.

Au, W.W.L., A. N. Popper, and R. R. Fay (eds), 2000. *Hearing by whales and dolphins*. Springer-Verlag: New York.

Avens, L., and K. J. Lohmann, 2003. Use of multiple orientation cues by juvenile loggerhead sea turtles (*Caretta caretta*). *The Journal of Experimental Biology,* Vol 206, pp 4317–4325.

Avens, L., and K. J. Lohmann, 2004. Navigation and seasonal migratory orientation in juvenile sea turtles. *The Journal of Experimental Biology,* Vol 207, pp 1771–1778.

Awbrey, F. T., J. A. Thomas, and R.A. Kastelein, 1988. Low-frequency underwater hearing sensitivity in belugas, *Delphinapterus leucas. Journal of the Acoustical Society of America,* Vol 84, pp 2273–2275.

Baird, R. W., 2001. Status of harbour seals, *Phoca vitulina*, in Canada. *Canadian Field-Naturalist*, Vol 115, No 4, pp 663–675.

Baird, R. W., 2002. False killer whale *Pseudorca crassidens*. in *Encyclopedia of Marine Mammals,* W. F. Perrin, B. Würsig, and J. G. M. Thewissen, eds. Academic Press: San Diego. pp 411–412.

Baird, R. W., A. D. Ligon, and S. K. Hooker, 2000. *Sub-surface and night-time behavior of humpback whales off Maui, Hawaii: A preliminary report*. Contract number 40ABNC050729. Prepared for the Hawaiian Islands Humpback Whale National Marine Sanctuary, Kihei, Hawaii by the Hawaii Wildlife Fund, Paia, Hawaii.

Baird, R. W., A. D. Ligon, S. K. Hooker, and A. M. Gorgone, 2001. Subsurface and nighttime behaviour of pantropical spotted dolphins in Hawaii. *Canadian Journal of Zoology,* Vol 79, pp 988–996.

Baird, R. W., D. J. McSweeney, M. R. Heithaus, and G. J. Marshall, 2003b. Short-finned pilot whale diving behavior: Deep feeders and day-time socialites, in *Abstracts, Fifteenth Biennial Conference on the Biology of Marine Mammals*, p 10. 14–19 December 2003. Greensboro, North Carolina.

Baird, R. W., D. L. Webster, D. J. McSweeney, A. D. Ligon, and G. S. Schorr, 2005b. Diving behavior and ecology of Cuvier's (*Ziphius cavirostris*) and Blainville's beaked whales (*Mesoplodon densirostris*) in Hawai'i. Order No. AB133F-04-RQ-0928. Prepared for Southwest Fisheries Science Center, La Jolla, California by Cascadia Research Collective, Olympia, Washington.

Baird, R. W., D. L. Webster, D. J. McSweeney, A. D. Ligon, G. S. Schorr, and J. Barlow, 2006. Diving behavior of Cuvier's (*Ziphius cavirostris*) and Blainville's (*Mesoplodon densirostris*) beaked whales in Hawai'i. *Canadian Journal of Zoology*, Vol 84, pp 1120–1128.

Baird, R. W., J. F. Borsani, M. B. Hanson, and P. L. Tyack, 2002. Diving and nighttime behavior of long finned pilot whales in the Ligurian Sea. *Marine Ecology Progress Series*, Vol 237, pp 301–305.

Baird, R. W., K. M. Langelier, and P. J. Stacey, 1989. First records of false killer whales, *Pseudorca crassidens*, in Canada. *Canadian Field-Naturalist*, Vol 103, pp 368–371.

Baird, R. W., M. B. Hanson, and L. M. Dill, 2005a. Factors influencing the diving behaviour of fish-eating killer whales: Sex differences and diel and interannual variation in diving rates. *Canadian Journal of Zoology*, Vol 83, pp 257–267.

Baird, R. W., M. B. Hanson, E. E. Ashe, M. R. Heithaus, and G. J. Marshall, 2003a. *Studies of foraging in "southern resident" killer whales during July 2002: Dive depths, bursts in speed, and the use of a "Crittercam" system for examining sub-surface behavior*. Order Number AB133F-02-SE-1744. Prepared for the National Marine Fisheries Service, National Marine Mammal Laboratory, Seattle, Washington.

Baird, R. W., P. J. Stacey, and H. Whitehead, 1993. Status of the striped dolphin, *Stenella coeruleoalba, in Canada*. *Canadian Field-Naturalist*, Vol 107, No 4, pp 455–465.

Baird, R. W., D. L. Webster, G. S. Schorr, and D. J. McSweeney, 2007. *Diel variation in beaked whale diving behavior*. Contract No. AB133F-06-CN-0053. Prepared for the National Marine Fisheries Service, Southwest Fisheries Science Center, La Jolla, California by Cascadia Research Collective, Olympia, Washington.

Baird, R. W., D. J. McSweeney, A. D. Ligon, and D. L. Webster, 2004. *Tagging feasibility and diving of Cuvier's beaked whales (Ziphius cavirostris) and Blainville's beaked whales (Mesoplodon densirostris) in Hawai'i.* Order No. AB133F-03-SE-0986. Prepared for Southwest Fisheries Science Center, National Marine Fisheries Service, La Jolla, California by Hawai'i Wildlife Fund, Volcano, Hawaii.

Ballard, K. A., and K. M. Kovacs, 1995. The acoustic repertoire of hooded seals (*Cystophora cristata*). *Canadian Journal of Zoology*, Vol 73, pp 1362–1374.

Balmer, B. C., and R. S. Wells, 2006. Bottlenose dolphin health assessment research: Radio-tracking summary St. Joseph Bay, Florida, April-July 2005. Sarasota, Florida: Center for Marine Mammal and Sea Turtle Research, Mote Marine Laboratory.

Banick, K., and J. L. Borger, 2005. A mass-stranding event of rough-toothed dolphins (*Steno bredanensis*) in the Florida Keys (Florida, USA): II. Release and tracking, in *Abstracts*, *Sixteenth Biennial Conference on the Biology of Marine Mammals*. 12–16 December 2005. San Diego, California. p 24.

Baraff, L. S., and T. R. Loughlin, 2000. Trends and potential interactions between pinnipeds and fisheries of New England and the U.S. West Coast. *Marine Fisheries Review*, Vol 62, pp 1–39.

Barco, S. G., W. A. McLellan, J. M. Allen, R. A. Asmutis-Silvia, R. Mallon-Day, E. M. Meagher, D. A. Pabst, J. Robbins, R. E. Seton, M. W. Swingle, M. T. Weinrich, and P. J. Clapham, 2002. Population identity of humpback whales (*Megaptera novaeangliae*) in the waters of the U.S. Mid-Atlantic states. *Journal of Cetacean Research and Management*, Vol 4, pp 135–141.

Barlas, M. E., 1999. The distribution and abundance of harbor seals (*Phoca vitulina concolor*) and gray seals (*Halichoerus grypus*) in southern New England, Winter 1998-Summer 1999. Master's thesis, Boston University.

Barlow, J., 2003a. *Preliminary estimates of the abundance of cetaceans along the U.S. west coast: 1991–2001*. NMFS-SWFSC Administrative Report LJ-03-03:1–31.

Barlow, J., 2003b. *Cetacean abundance in Hawaiian waters during summer/fall of 2002*. NMFS-SWFSC Administrative Report LJ-03-13:1–20.

Barlow, J., 2006a. Cetacean abundance in Hawaiian waters estimated from a summer/fall survey in 2002. *Marine Mammal Science*, Vol 22, No 2, pp 446–464.

Barlow, J., and B. L. Taylor. 2001. *Estimates of large whale abundance off California, Oregon, Washington, and Baja California based on 1993 and 1996 ship surveys*. NFMS-SWFSC Administrative Report LJ-01-03:1–12.

Barlow, J., and B. L. Taylor. 2005. Estimates of sperm whale abundance in the northeastern temperate Pacific from a combined acoustic and visual survey. *Marine Mammal Science*, Vol 21, No 3, pp 429–445.

Barlow, J., and K. A. Forney. 2007. Abundance and population density of cetaceans in the California Current ecosystem. *Fishery Bulletin*, Vol 105, pp 509–526.

Barlow, J., and K. Forney, 2007. Abundance and population density in the California current ecosystem. *Fishery Bulletin*, Vol 105, No 4, pp 509–526. LaJolla.

Barlow, J., and R. Gisiner, 2006. Mitigating, monitoring, and assessing the effects of anthropogenic sound on beaked whales. *Journal of Cetacean Research and Management*, Vol 7, No 3, pp 239–249.

Barlow, J., and S. Sexton, 1996. *The effect of diving and searching behavior on the probability of detecting track-line groups, go, of long-diving whales during line-transect surveys*. NMFS-SWFSC Administrative Report LJ-96-14:1–21.

Barlow, J., and T. Gerrodette. 1996. *Abundance of cetaceans in California waters based on 1991 and 1993 ship surveys*. NOAA Technical Memorandum NMFS-SWFSC-233:1–15.

Barlow, J., 1995. The abundance of cetaceans in California waters. Part I: Ship surveys in summer and fall of 1991. *Fishery Bulletin*, Vol 93, No 1, pp 1–14.

Barlow, J., 1999. Trackline detection probability for long-diving whales, in *Marine Mammal Survey and Assessment Methods*, G. W. Garner, S. C. Amstrup, J. L. Laake, B. F. J. Manly, L. L. McDonald, and D. G. Robertson, eds. A. A. Balkema: Brookfield, Vermont. pp 209–221.

Barlow, J., 2003c. *Acoustic Identification of Nine Delphinid Species in the Eastern Tropical Pacific Ocean*. NMFS, Southwest Fisheries Science Center.

Barlow, J., 2006b. *Lessons from monitoring trends in abundance of marine mammals*. NMFS, Southwest Fisheries Science Center.

Barlow, J., C. W. Oliver, T. D. Jackson, and B. L. Taylor. 1988. Harbor porpoise, *Phocoena phocoena*, abundance estimation for California, Oregon, and Washington: II. Aerial surveys. *Fishery Bulletin*, Vol 86, No 3, pp 433–444.

Barlow, J., K. Forney, A. Von Saunder, and J. Urban-Ramirez. 1997. *A report of Cetacean Acoustic Detection and Dive Interval Studies (CADDIS) conducted in the southern Gulf of California, 1995*. NOAA Technical Memorandum NMFS-SWFSC-250:1–48.

Barlow, J., M. C. Ferguson, W. F. Perrin, L. Ballance, T. Gerrodette, G. Joyce, C. D. MacLeod, K. Mullin, D. L. Palka, and G. Waring. 2006. Abundance and densities of beaked and bottlenose whales (family Ziphiidae). *Journal of Cetacean Research and Management*, Vol 7, No 3, pp 263–270.

Baron, S., 2006. Personal communication via email between Dr. Susan Baron, National Marine Fisheries Service, Southeast Fisheries Science Center, Miami, Florida, and Dr. Amy R. Scholik, Geo-Marine, Inc., Hampton, Virginia, on 31 August 2006.

Barr, J. F., C. Eberl, and J. W. McIntyre, 2000. Red-throated Loon (*Gavia stellata*), in *The Birds of North America, No. 513,* A. Poole and F. Gill, eds. The Birds of North America, Inc.: Philadelphia, PA.

Barron, G. L., and T. A. Jefferson, 1993. First records of the melon-headed whale (*Peponocephala electra*) from the Gulf of Mexico. *Southwestern Naturalist*, Vol 38, No 1, pp 82–85.Baumgartner, M. F., 1997. The distribution of Risso's dolphin (*Grampus griseus*) with respect to the physiography of the northern Gulf of Mexico. *Marine Mammal Science*, Vol 13, No 4, pp 614–638.

Baumgartner, M. F., and B. R. Mate, 2003. Summertime foraging ecology of North Atlantic right whales. *Marine Ecology Progress Series*, Vol 264, pp 123–135.

Baumgartner, M. F., K. D. Mullin, L. N. May, and T. D. Leming, 2001. Cetacean habitats in the northern Gulf of Mexico. *Fishery Bulletin,* Vol 99, pp 219–239.

Baumgartner, M. F., T. V. N. Cole, R. G. Campbell, G. J. Teegarden, and E. G. Durbin, 2003. Associations between North Atlantic right whales and their prey, *Calanus finmarchicus*, over diel and tidal time scales. *Marine Ecology Progress Series*, Vol 264, pp 155–166.

Baumgartner, M., and F. Wenzel, 2005. Observations of Near-bottom Foraging by Right Whales in the Great South Channel. Atlantic Ocean Right Whale Consortium Annual Meeting, New Bedford Whaling Museum: New Bedford, Massachusetts.

Baumgartner, M. F., S. M. Van Parijs, F. W. Wenzel, C. J. Tremblay, H. C. Esch, and A. M. Warde, 2008. Low frequency vocalizations attributed to sei whales (*Balaenoptera borealis*). *Journal of the Acoustical Society of America* Vol. 124, No. 2, pp 1339–1349.

Bazúa-Durán, C., and W. W. L. Au, 2002. The whistles of Hawaiian spinner dolphins. *Journal of the Acoustical Society of America*, Vol 112, No 6, pp 3064–3072.

Beamish, P., and E. Mitchell, 1973. Short pulse length audio frequency sounds recorded in the presence of a minke whale (*Balaenoptera acutorostrata*). *Deep-Sea Research*, Vol 20, pp 375–386.

Beck, C., 2006a. Personal communication via email between Ms. Cathy Beck, U.S. Geological Survey, Sirenia Project, Gainsville, Florida, and Ms. Dagmar Fertl, Geo-Marine, Inc., Plano, Texas, on 6 September, and 27 October, 2006.

Beck, C., 2006b. Florida manatee travels to Cape Cod, Massachusetts. *SireNews*, Vol 46, pp 15–16.

Bejder, L., Samuels, A., Whitehead, H., and Gales, N., 2006. Interpreting short-term behavioral responses to disturbance within a longitudinal perspective. *Animal Behaviour*, Vol 72, pp 1149–1158.

Bekkby, T., and A. Bjorge, 2003. Joint diving behaviour of harbour seal (*Phoca vitulina*) females and pups in the lactation period. *Sarsia*, Vol 88, pp 369–372.

Benoit-Bird, K. J., 2004. Prey caloric value and predator energy needs: Foraging predictions for wild spinner dolphins. *Marine Biology*, Vol 145, pp 435–444.

Benoit-Bird, K. J. and W. W. L, Au, 2004. Diel migration dynamics of an island-associated sound-scattering layer. *Deep-Sea Research I,* Vol 51, pp 707–719.

Benoit-Bird, K. J. and W. W. L, Au,, 2003. Prey dynamics affect foraging by a pelagic predator (*Stenella longirostris*) over a range of spatial and temporal scales. *Behavioral Ecology and Sociobiology*, Vol 53, pp 364–373.

Benoit-Bird, K. J., W. W. L. Au, R. E. Brainard, and M. O. Lammers, 2001. Diel horizontal migration of the Hawaiian mesopelagic boundary community observed acoustically. *Marine Ecology Progress Series*, Vol 217, pp 1–14.

Berchok, C. L., D. L. Bradley, and T. B. Gabrielson, 2006. St. Lawrence blue whale vocalizations revisited: Characterization of calls detected from 1998 to 2001. *Journal of the Acoustical Society of America*, Vol 120, No 4, pp 2340–2354.

Bernard, H. J., and S. B. Reilly, 1999. Pilot whales *Globicephala* Lesson, 1828, in *Handbook of Marine Mammals, Vol 6: The Second Book of Dolphins and the Porpoises*, S. H. Ridgway and R. Harrison, eds. Academic Press: San Diego, California. pp 245–279.

Berry, K. A., M. E. Peixoto, and S. S. Sadove, 2000. Occurrence, distribution and abundance of green turtles, *Chelonia mydas*, in Long Island, New York: 1986-1997, in *Proceedings of the Eighteenth International Sea Turtle Symposium*, F.A. Abreu-Grobois, R. Briseño, R. Márquez, and L. Sarti, eds. NOAA Technical Memorandum NMFS-SEFSC-436. p 149.

Berzin, A. A., 1972. The Sperm Whale, Yablokov, A. V. ed. in *Jerusalem, Israel Program for Scientific Translations.* p 258.

Best, P. B., and C. H. Lockyer, 2002. Reproduction, growth and migrations of sei whales *Balaenoptera borealis* off the west coast of South Africa in the 1960s. *South African Journal of Marine Science*, Vol 24, pp 111–133.

Biassoni, N., P. J. Miller, and P. L. Tyack, 2000. *Preliminary Results of the Effects of SURTASS-LFA Sonar on Singing Humpback Whales*. Woods Hole Oceanographic Institute, Technical Report No. 2000-06. Woods Hole, Massachusetts.

Bibikov, N. G., 1992. Auditory brainstem responses in the harbor porpoise (*Phocoena phocoena*), in *Marine mMammal Sensory Systems,* J. A. . Thomas, R. A. Kastelein, and A.Y. Supin, eds. Plenum Press: New York. pp 197–211.

Bigg, M. A., 1981. Harbour seal *Phoca vitulina* Linnaeus, 1758 and *Phoca largha* Pallas, 1811, in *Handbook of marine mammals, Vol. 2: Seals*, S. H. Ridgway and R. Harrison, eds. Academic Press: San Diego. p 1–87.Biggs, D. C., R. R. Leben, and J. G. Ortega-Ortiz, 2000. Ship and satellite studies of mesoscale circulation and sperm whale habitats in the northeast Gulf of Mexico during GulfCet II. *Gulf of Mexico Science*, Vol 18, No 1, pp 15–22.

BirdLife International, 2006. Bermuda Petrel – BirdLife Species Factsheet. Retrieved from http://www.birdlife.org/datazone/species/index.html?action=SpcHTMDetails.asp&sid=3910&m=0, on 9 May 2008.

Bjorndal, K. A., A. B. Bolten, and H. R. Martins, 2000a. Somatic growth model of juvenile loggerhead sea turtles *Caretta caretta*: duration of pelagic stage. *Marine Ecology Progress Series*, Vol 202, pp 265–272.

Bjorndal, K. A., A. B. Bolten, and M. Y. Chaloupka, 2000b. Green turtle somatic growth model: evidence for density-dependence. *Ecological Applications*, Vol 10, pp 269–282.

Bjorndal, K. A., A. B. Bolten, B. Koike, B. A. Schroeder, D. J. Shaver, W. G. Teas, and W. N. Witzell, 2001. Somatic Growth Function for Immature Loggerhead Sea Turtles, *Caretta caretta*, in Southeastern U.S. Waters. *Fishery Bulletin, Vol* 99, pp 240–246.

Bjorndal, K. A., and A. B. Bolten, 1988. Growth rates of immature green turtles, *Chelonia mydas*, on feeding grounds in the southern Bahamas. *Copeia*, Vol 1988, pp 555–564.

Blackwell, S. B., J. W. Lawson, and M. T. Williams, 2004. Tolerance by ringed seals (*Phoca hispida*) to impact pipe-driving and construction sounds at an oil production island. *Journal of the Acoustical Society of America*, Vol 115, pp 2346–2357.

Blaylock, R. A., J. W. Hain, L. J. Hansen, D. L. Palka, and G. T. Waring, 1995. *U.S. Atlantic and Gulf of Mexico marine mammal stock assessments*. NOAA Technical Memorandum NMFS-SEFSC-363:1–211.

Bleakney, J. S., 1965. Reports of marine turtles from New England and eastern Canada. *Canadian Field-Naturalist*, Vol 79, pp 120–128.

Blodget, B. G., 2002. *Bird List for the Commonwealth of Massachusetts*. Massachusetts Division of Fish and Wildlife. June 2002.

Bodson, A., L. Miersch, B. Mauck, and G. Dehnhardt, 2006. Underwater auditory localization by a swimming harbor seal (*Phoca vitulina*). *Journal of the Acoustical Society of America*, Vol 120, No 3, pp 1550–1557.

Boicourt, B., 2004. The hydraulics of a hot spot. *Chesapeake Quarterly Online*, Vol 3, No 1.

Bolaños, J., and A. Villarroel-Marin, 2003. Three new records of cetacean species for Venezuelan waters. *Caribbean Journal of Science*, Vol 39, No 2, pp 230–232.

Bolten, A. B., and G. H. Balazs, 1995. Biology of the early pelagic stage–the "lost year." in *Biology and Conservation of Sea Turtles*, K.A. Bjorndal, ed., rev. ed. Smithsonian Institution Press: Washington, D.C. pp 579–581.

Bolten, A. B., K. A. Bjorndal, H. R. Martins, T. Dellinger, M. J. Biscoito, S. E. Encalada, and B. W. Bowen, 1998. Transatlantic developmental migrations of loggerhead sea turtles demonstrated by mtDNA sequence analysis. *Ecological Applications*, Vol 8, pp 1–7.

Bolten, A., K. A. Bjorndal, and H.R. Martins, 1994. *Biology of Pelagic-Stage Loggerheads in the Atlantic*. Proceedings, Fourteenth Annual Symposium on Sea Turtle Biology and Conservation. National Oceanic and Atmospheric Administration Technical Memorandum.

Bonner, W. N., 1981. Grey seal *Halichoerus grypus* Fabricius, 1791. in *Handbook of Marine Mammals, Vol 2: Seals*, S. H. Ridgway and R. Harrison, eds. Academic Press: San Diego. pp 111–144.

Borener, S., and J. Maugham, 1998. *Volpe A to N [Aid to Navigation] Battery Scientific Assessment*. United States Coast Guard AtoN Battery Scientific Assessment, DOT-VNTSC-CG-98-01. Enclosure 1 in National Plan for AtoN Battery Recovery and Disposal, COMDTINST 16478.12. U.S. Department of Transportation, U.S. Coast Guard. Retrieved from http://www.uscg.mil/ccs/cit/cim/directives/CI/CI_16478_12.pdf.

Born, E. W., L. W. Andersen, I. Gjertz, and O. Wiig, 2001. A review of the genetic relationships of Atlantic walrus (*Odobenus rosmarus rosmarus*) east and west of Greenland. *Polar Biology*, Vol 24, pp 713–718.

Boskovic, R., K. M. Kovacs, M. O. Hammill, and B. N. White, 1996. Geographic distribution of mitochondrial DNA haplotypes in grey seals (*Halichoerus grypus*). *Canadian Journal of Zoology*, Vol 74, pp 1787–1796.

Bossart, G. D., L. Hansen, J. D. Goldstein, D. Kilpatrick, S. Bechdel, E. Howells, K. Kroell, M. De Sieyes, M. K. Stolen, W. K. Durden, J. S. Reif, R. H. Defran, and S. D. McCulloch. 2007. Pathologic findings in a rare mass stranding of melon-headed whales (*Peponocephala electra*) in Florida. *Aquatic Mammals*, Vol 33, No 2, pp 235–240.

Boulva, J., 1973. The harbour seal, *Phoca vitulina concolor*, in eastern Canada. PhD dissertation, Dalhousie University.

Bowen B. W., W. S. Grant, Z. Hills-Starr, D. J. Shaver, S. K. A. Bjorndal, A. B. Bolten, and A. L. Bass, 2007. Mixed-stock analysis reveals the migrations of juvenile hawksbill turtles (*Eretmochelys imbricate*) in the Caribbean Sea. *Molecular Biology*, Vol 16, pp 49–60.

Bowen, W. D. and D. B. Siniff, 1999. Distribution, population biology, and feeding ecology of marine mammals. in *Biology of Marine Mammals*, Reynolds III, J.E. and S.A. Rommel, eds. Smithsonian Institution Press: Washington, D.C. pp 423–484.

Bowen, W. D., D. J. Boness, and S. J. Iverson, 1999. Diving behaviour of lactating harbour seals and their pups during maternal foraging trips. *Canadian Journal of Zoology*, Vol 77, pp 978–988.

Bowen, W. D., J. McMillan, and R. Mohn, 2003. Sustained exponential population growth of grey seals at Sable Island, Nova Scotia. *ICES Journal of Marine Science*, Vol 60, pp 1265–1274.

Bowles, A. E., C. D. Alves, and R. C. Anderson, 2001. *Manatee behaviors in the presence of fishing gear: response to novelty and the potential for reducing gear interactions*. Report by Hubbs-SeaWorld Research Institute, San Diego, CA, for U.S. Fish and Wildlife Service, Jacksonville, FL on Purchase Order 401819M390. Hubbs-SeaWorld Research Institute Technical Report No. 2001317.

Bowles, A. E., M. Smultes, B. Würsig, D. P. DeMaster, and D. Palka, 1994. Relative abundance and behavior of marine mammals exposed to transmissions from the Heard Island Feasibility Test. *Journal of the Acoustical Society of America*, Vol 96, No 4, pp 2469–2484.

Bowles, A. E., T. M. Yack, J. S. Jaffe, and F. Simonet, 2004. Design for a Manatee Finder: Sonar Techniques to Prevent Manatee-Vessel Collisions. Prepared for Fish and Wildlife Conservation Commission, Florida Marine Research Institute. St. Petersburg, FL. Accessed online December 13, 2007 at: http://research.myfwc.com/engine/download_redirection_process.asp?file=fmri_report_022804-fin_0618.pdf&objid=14362&dltype=article.

Boyd, I. L., and J. P. Croxall, 1996. Dive durations in pinnipeds and seabirds. *Canadian Journal of Zoology*, Vol 74, pp 1696–1705.

Bradshaw, C. J., K. Evans, and M. A. Hindell, 2006. Mass cetacean strandings: A plea for empiricism. *Conservation Biology*, Vol 20, pp 584–586.

Braune, B. M. 1987a. Seasonal aspects of the diet of Bonaparte's Gull (*Larus philadelphia*) in the Quoddy Region, New Brunswick, Canada. *The Auk*, Vol 104, pp 167–172.

Breese, D. and B. R. Tershy, 1993. Relative abundance of Cetacea in the Canal de Ballenas, Gulf of California. *Marine Mammal Science,* Vol 9, No 3, pp 319–324.

Brill, R. W., G.H. Balazs, K. N. Holland, R. K. C. Chang, S. Sullivan, and J. George, 1995. Daily movements, habitat use, and submergence intervals of normal and tumor-nearing juvenile green turtles (*Chelonia mydas* L.) within a foraging area in the Hawaiian Islands.

Broadwater Energy, 2007. Need for the Project. Retrieved from http://www.broadwaterenergy.com/pdf/ Broadwater_Project_ Update.pdf on 18 October 2007.

Brodie, P. F., 1989. The white whale *Delphinapterus leucas* (Pallas, 1776), in *Handbook of Marine Mammals,* S. H. Ridgway and R. Harrison, eds. Vol 4. Academic Press: London. pp 119–144.

Brongersma, L. D., 1972. European Atlantic turtles. *Zoologische Verhandelingen*, Vol 121, pp 1–318.

Brown Gladden, J. G., M. M. Ferguson, M. K. Friesen, and J. W. Clayton, 1999. Population structure of North American beluga whales (*Delphinapterus leucas*) based on nuclear DNA microsatellite variation and contrasted with the population structure revealed by mitochondrial DNA variation. *Molecular Ecology*, Vol 8, pp 347–363.

Brown Gladden, J. G., P. F. Brodie, and J. W. Clayton, 1999. Mitochondrial DNA used to identify an extralimital beluga whale (*Delphinapterus leucas*) from Nova Scotia as originating from the St. Lawrence population. *Marine Mammal Science*, Vol 15, No 2, pp 556–558.

Brown, D. H., D. K. Caldwell, and M. C. Caldwell, 1966. Observations on the behavior of wild and captive false killer whales, with notes on associated behavior of other genera of captive delphinids. Contributions in Science, Natural History Museum of Los Angeles County. Vol 95, pp 1–32.

Buck, J. R. and P. L. Tyack, 2000. Response of gray whales to low-frequency sounds. In Abstract: *Journal of the Acoustic Society of America*, Vol 107, No 5, Part 2: 2774.

Bullock, T. H., T. J. O'Shea, and M. C. McClune, 1982. Auditory evoked potentials in the West Indian manatee (Sirenia: *Trichechus manatus)*. *Journal of Comparative Physiology,* Vol 148, pp 547–554.

Burger, J. and M. Gochfeld, 1996. Family Laridae (gulls), in *Handbook of the Birds of the World,* J. del Hoyo, A. Elliott, and J. Sargatal, eds. pp 572–623. Vol. 3. Lynx Edicions: Barcelona, Spain.

Burger, J., 1996. Laughing Gull (*Larus atricilla*), in *The Birds of North America*, A. Poole and F. Gill, eds. No. 225. The Academy of Natural Sciences, Philadelphia, PA, and The American Ornithologists' Union, Washington, D.C.

Burger, J., and M. Gochfeld, 2002. Bonaparte's Gull (*Larus philadelphia*), in *The Birds of North America* No. 634, A. Poole and F. Gill, eds. The Birds of North America, Inc.: Philadelphia, PA.

Burke, V. J., S. J. Morreale, P. Logan, and E. A. Standora, 1992. Diet of green turtles (*Chelonia mydas*) in the waters of Long Island, N.Y., in the *Proceedings of the Eleventh Annual Workshop on Sea Turtle Biology and Conservation*, Salmon and J. Wyneken, eds. pp 140–142.

Burnham, M., 2007. Entrepreneurs Start Testing Waters for Offshore Hydropower. Retrieved from http://www.eenews.net/special_reports/new_wave/, on 24 July 2007.

Butterworth, D. S., and D. L. Borchers, 1988. Estimates of g(0) for minke schools from the results of the independent observer experiment on the 1985/86 and 1986/87 IWC/IDCR Antarctic assessment cruises. *Reports of the International Whaling Commission*, Vol 38, pp 301–313.

Byles, R. A., 1988. *Behavior and ecology of sea turtles from Chesapeake Bay, Virginia.* Ph.D. dissertation, College of William and Mary in Virginia.

Byles, R. A., 1989. Satellite Telemetry of Kemp's Ridley Sea Turtle, *Lepidochelys kempi*, in the Gulf of Mexico. *Proceedings, Ninth Annual Workshop on Sea Turtle Conservation and Biology*. National Oceanic and Atmospheric Administration Technical Memorandum.

Calambokidis, J., and J. Barlow, 2004. Abundance of blue and humpback whales in the eastern North Pacific estimated by capture-recapture and line-transect methods. *Marine Mammal Science,* Vol 20, No 1, pp 63–85.

Calambokidis, J., E. Oleson, M. McDonald, B. Burgess, J. Francis, G. Marshall, M. Bakhtiari, and J. Hildebrand, 2003. Feeding and vocal behavior of blue whales determined through simultaneous visual-acoustic monitoring and deployment of suction-cap attached tags. Page 27 in *Abstracts, Fifteenth Biennial Conference on the Biology of Marine Mammals*. pp 14–19. December 2003. Greensboro, North Carolina.

Calambokidis, J., G. H. Steiger, J. M. Straley, L. M. Herman, S. Cerchio, D. R. Salden, J. Urbán R, J. K. Jacobsen, O. von Ziegesar, K. C. Balcomb, C. M. Gabriele, M. E. Dahlheim, S. Uchida, G. Ellis, Y. Miyamura, P. Ladrón de Guevara P., M. Yamaguchi, F. Sato, S.A. Mizroch, L. Schlender, K. Rasmussen, J. Barlow, and T. J. Quinn II, 2001. Movements and population structure of humpback whales in the North Pacific. *Marine Mammal Science*, Vol 17, No 4, pp 769–794.

Calambokidis, J., J. C. Cubbage, J. R. Evenson, S.D. Osmek, J. L. Laake, P. J. Gearin, B. J. Turnock, S. J. Jeffries, and R. F. Brown, 1993b. *Abundance estimates of harbor porpoise in Washington and Oregon waters*. Prepared for the National Marine Fisheries Service, Seattle, Washington, by Cascadia Research Collective, Olympia, Washington.

Calambokidis, J., J. R. Evenson, J. Cubbage, S. D. Osmek, S. D. Rugh, D. Rugh, and J. L. Laake, 1993a. Calibration of sighting rates of harbor porpoise from aerial surveys. Prepared for the National Marine Fisheries Service, Seattle, Washington, by Cascadia Research Collective, Olympia, Washington.

Caldwell, D. K., and F. B. Golley, 1965. Marine mammals from the coast of Georgia to Cape Hatteras. *Journal of the Elisha Mitchell Scientific Society*, Vol 81, No 1, pp 24–32.

Caldwell, D. K., and M. C. Caldwell,1971. Beaked whales, Z*iphius cavirostris*, in the Bahamas. *Quarterly Journal of the Florida Academy of Sciences*, Vol 34, No 2, pp157–160.

Caldwell, D. K., and M.C. Caldwell, 1969. The harbor seal, *Phoca vitulina concolor*, in Florida. *Journal of Mammalogy*, Vol 50, No 2, pp 379–380.

Caldwell, D. K., 1968. Baby loggerhead turtles associated with sargassum weed. *Journal of the Florida Academy of Sciences*, Vol 31, pp 271–272.

Caldwell, D. K., and M.C. Caldwell, 1965. Individualized whistle contours in bottlenose dolphins (*Tursiops truncatus*), *Nature*, Vol 207, pp 434–435.

California Energy Commission, 2007. Ocean Energy. Retrieved from http://www.energy.ca.gov/development/oceanenergy/, on 24 July 2007.

Caltrans, 2001. Pile Installation Demonstration Project, Fisheries Impact Assessment. PIPD EA 012081, Caltrans Contract No. 04A0148. San Francosco-Oakland Bay Bridge East Span Seismic Safety Project.

Caltrans, 2004. Fisheries and Hydroacoustic Monitoring Program Compliance report for the San Francisco-Oakland Bay Bridge east Span Seismic Safety Project. Prepared by Strategic Environmental Consulting, Inc. and Illingworth & Rodkin, Inc. June.

Campbell, R. R., 1987. Status of the hooded seal, *Cystophora cristata*, in Canada. *Canadian Field-Naturalist*, Vol 101, pp 253–265.

Cañadas, A., G. Desportes, and D. Borchers, 2004. The estimation of the detection function and g(0) for short-beaked common dolphins (Delphinus delphis), using double-platform data collected during the NASS-95 Faroese survey. *Journal of Cetacean Research and Management*, Vol 6, No 2, pp 191–198.

Cape Wind Associates, LLC, 2007. Cape Wind: America's First Offshore Wind Farm on Nantucket Sound–Where will the energy we produce go? Retrieved from http://www.capewind.org/article34.htm, on 10 May 2007.

Caribbean Conservation Corporation (CCC), 2002. Florida leatherback tracking project: China Girl. Accessed 6 November 2002. http://www.cccturtle.org/satgirl.htm.

Carr, A., 1987. New perspectives on the pelagic stage of sea turtle development. *Conservation Biology*, Vol 1, pp 103–121.

Carr, A., 1995. Notes on the behavioral ecology of sea turtle development. *Conservation Biology*, Vol 1, No 2, pp 103–121.

Carr, A., and A. B. Meylan, 1980. Evidence of passive migration of green turtle hatchlings in *Sargassum*. *Copeia*, Vol 1980, pp 366–368.

Carr, A., L. H. Ogren, and C. McVea. 1980. Apparent hibernation by the Atlantic loggerhead turtle *Caretta caretta* off Cape Canaveral, Florida. *Biological Conservation*, Vol 19, pp 7–14.

Carretta, J. V., B. L. Taylor, and S. J. Chivers. 2001. Abundance and depth distribution of harbor porpoise (*Phocoena phocoena*) in northern California determined from a 1995 ship survey. *Fishery Bulletin*, Vol 99, pp 29–39.

Carretta, J. V., K. A. Forney, M. M. Muto, J. Barlow, J. Baker, B. Hanson, and M. S. Lowry. 2007. Final U.S. *Pacific marine mammal stock assessments: 2006*. NOAA Technical Memorandum NMFS-SWFSC-398, pp 1–312.

Carretta, J. V., K. A. Forney, M. M. Muto, J. Barlow, J. Baker, B. Hanson, and M. S. Lowry, 2007. *U.S. Pacific Marine Mammal Stock Assessments: 2006.* NOAA Technical Memorandum NMFS-SWFSC-398, p 321.

Carretta, J. V., K. A. Forney, M. M. Muto, J. Barlow, J. Baker, B. Hanson, and M. S. Lowry, 2007. *Final U.S. Pacific marine mammal stock assessments: 2006*. NOAA Technical Memorandum NMFS-SWFSC-398, pp 1–312.

Carretta, J. V., M. S. Lowry, C. E. Stinchcomb, M. S. Lynn, and R. E. Cosgrove. 2000. *Distribution and abundance of marine mammals at San Clemente Island and surrounding offshore waters: Results from aerial and ground surveys in 1998 and 1999*. NMFS- SWFSC Administrative Report LJ-00-02:1–43.

Casper, B. M., and D. A. Mann, 2006. Dipole hearing measurements in elasmobranch fishes. *Journal of Experimental Biology*, Vol 210, pp 75–81.

Casper, B. M., P. S. Lobel, and H. Y. Yan, 2003. The hearing sensitivity of the little skate, *Raja erinacea*: A comparison of two methods. *Environmental Biology of Fishes*, Vol 68, pp 371–379.

Caswell, H., M. Fujiwara, and S. Brault, 1999. Declining survival probability threatens the North Atlantic right whale. *Proceedings of the National Academy of Sciences of the United States of America*, Vol 96, pp 3308–3313.

CETAP (Cetacean and Turtle Assessment Program), 1982. *Characterization of marine mammals and turtles in the mid- and North Atlantic areas of the U.S. outer continental shelf*. Final report to the U.S. Bureau of Land Management, Washington, D.C., from the Graduate School of Oceanography, University of Rhode Island, Kingston. NTIS PB83-215855.

Centers for Disease Control and Prevention, 2003. Sixteenth Meeting of the Advisory Board on Radiation and Worker Health May 19-20, 2003. Oak Ridge, Tennessee.

Charif, R. A., D. K. Mellinger, K. J. Dunsmore, K. M. Fristrup, and C. W. Clark, 2002. Estimated source levels of fin whale (*Balaenoptera physalus*) vocalizations: Adjustments for surface interference. *Marine Mammal Science*, Vol 18, No 1, pp 81–98.

Chesapeake Biological Laboratory (CBL), 2006. Fisheries Ecosystem Evaluation. Last updated Wednesday, 25 October 2006. Retrieved from http://www.cbl.umces.edu/cms108/index2.php?option=com_content&do_pdf=1&id=33, on 27 June 2007.

Chivers, S. J., R. G. LeDuc, K. M. Robertson, N. B. Barros, and A. E. Dizon, 2005. Genetic variation of *Kogia* spp. with preliminary evidence for two species of *Kogia sima*. *Marine Mammal Science*, Vol 21, No 4, pp 619–634.

Chou, L. S., 2005. Personal communication via email between Dr. Lien-Siang Chou, National Taiwan University, Taipei, Taiwan, and Dr. Amy R. Scholik, Geo-Marine, Inc., Hampton, Virginia, 11 January.

Christenson, M., 2006. Boat crew spots whale birth in nearby waters. Retrieved from http://www.caller.com/ccct/local_news/article/0,1641,CCCT_811_4891666,00.html, on January 16, 2007.

City of North Charleston, 2008. Economic Development: Infrastructure. Retrieved from http://www.northcharleston.org/EconDev/Infrastructure.aspx, on 21 April, 2008.

Clapham P. J., Baraff L. S., Carlson C. A., Christian M. A., Mattila D. K., Mayo C. A., Murphy M. A., Pittman S., 1993. Seasonal occurrence and annual return of humpback whales (*Megaptera novaeangliae*) in the southern Gulf of Maine. *Canadian Journal of Zoology,* Vol 71, pp 440–443.

Clapham, P. J., 1996. The social and reproductive biology of humpback whales: An ecological perspective. *Mammal Review*, Vol 26, No 1, pp 27–49.

Clapham, P. J., and D. K. Mattila, 1990. Humpback whale songs as indicators of migration routes. *Marine Mammal Science*, Vol 6, pp 155–160.

Clapham, P. J., and J. G. Mead, 1999. *Megaptera novaeangliae*. *Mammalian Species*, Vol 604, pp 1–9.

Clapham, P. J., S. B. Young, and R. L. Brownell, 1999. Baleen whales: Conservation issues and the status of the most endangered populations. *Mammal Review*, Vol 29, No 1, pp 35–60.

Clapham, P., J. Barlow, M. Bessinger, T. Cole, D. Mattila, R. Pace, D. Palka, J. Robbins, and R. Seton, 2003. Abundance and demographic parameters of humpback whales from the Gulf of Maine, and stock definition relative to the Scotian Shelf. *Journal of Cetacean Research and Management*, Vol 5, No 1, pp 13–22.

Clapham, P., S. Leatherwood, I. Szczepaniak, and R.L. Brownell, Jr., 1997. Catches of humpback and other whales from shore stations at Moss Landing and Trinidad, California, 1919–1926. *Marine Mammal Science*, Vol 13, No 3, pp 368–394.

Clark, C. W. and G. J. Gagnon, 2004. Low-frequency vocal behaviors of baleen whales in the North Atlantic: Insights from Integrated Undersea Surveillance System detections, locations, and tracking from 1992 to 1996. US Navy. *Journal of Underwater Acoustics*, Vol 52, No 3.

Clark, C. W. and K. M. Fristrup, 1997. Whales '95: A combined visual and acoustic survey of blue and fin whales off southern California. *Reports of the International Whaling Commission*, Vol 47, pp 583–600.

Clark, C. W. and W. T. Ellison, 2004. Potential use of low-frequency sounds by baleen whales for probing the environment: Evidence from models and empirical measurements in *Echolocation in bats and dolphins*, Thomas, J.A., C.F. Moss, and M. Vater, eds. University of Chicago Press: Chicago, Illinois. pp 564–582.

Clark, C. W., 1995. Annex M, matters arising out of the discussion of blue whales: Annex M1, application of the U.S. Navy underwater hydrophone arrays for scientific research on whales. *Reports of the International Whaling Commission*, Vol 45, pp 210–212.

Clark, C. W., and P. J. Clapham, 2004. Acoustic monitoring on a humpback whale (*Megaptera novaeangliae*) feeding ground shows continual singing into late spring. *Proceedings of the Royal Society of London*, Part B Vol 271, pp 1051–1057.

Clark, L. S., Cowan, D. F., and Pfeiffer, D. C., 2006. Morphological changes in the Atlantic bottlenose dolphin (*Tursiops truncatus*) adrenal gland associated with chronic stress. *Journal of Comparative Pathology*, Vol 135, pp 208–216.

Clark, L. S., D. F. Cowan, G. A. J. Worthy, and E. M. Haubold, 2002. An anatomical and pathological examination of the first recorded stranding of a Fraser's dolphin (*Lagenodelphis hosei*) in the northwestern Gulf of Mexico. *Gulf of Mexico Science*, Vol 20, No 1, pp 38–43.

Clarke, R., 1993. Personal communication via letter from Roger A. Clarke (Director, Directorate of Compliance Programs, OSHA) to Joe Jackson (Amarillo Gear Co.) regarding how "articles" are considered exempt from the Hazardous Communication Standard on 27 January 1993. Retrieved from http://www.osha.gov/pls/oshaweb/owadisp.show_document?p_table=INTERPRETATIONS&p_id=21008.

Coast Guard, 2007. Notice of Study and Request for Comments for the Port Access Route Study of Potential Vessel Routing Measures to Reduce Vessel Strikes of North Atlantic Right Whale. *Federal Register*, Department of Homeland Security; Coast Guard. 19 November 2007. *Federal Register* 72, No. 222, pp 64968–70.

Coastal Environments, Inc., 1977. *Cultural Resources Evaluation of the Northern Gulf of Mexico Continental Shelf: Vol. I, Prehistoric Cultural Resource Potential*. A Final Report for the U.S. Department of the Interior, National Park Service, Office of Archeology and Historic Preservation. NTIS No. PB276773/AS. Contract No. 08550-MU5-40. 361 pp.

Coasts and Oceans, 2002. The State of the Nation's Ecosystems: Selected Contaminants in Fish and Shellfish. 2002 Report. Retrieved fromt www.heinzctr.org/ecosystems/coastal/cntm_fish.shtml, on 14 January 2008. Last revised on 25 January 2006. Coles, P., 2001. Identifying beaked whales at sea in North Atlantic waters. *A report on the whales, dolphins and seabirds of the Bay of Biscay and English Channel*, Cresswell, G. and D. Walker, eds. Shetland Islands, United Kingdom: Organisation Cetacea (ORCA). pp 81–90.

Coles, W. C. and J. A. Musick, 2000. Satellite Sea Surface Temperature Analysis and Correlation with Sea Turtle Distribution off North Carolina. *Copeia*,Vol 2000, pp 551–554.

Collard, S. B., 1990a. Leatherback Turtles Feeding Near a Warmwater Mass Boundary in the Eastern Gulf of Mexico. *Marine Turtle Newsletter*, Vol 50, pp 12–14.

Collard, S. B., 1990b. The influence of oceanographic features in post-hatchling sea turtle distribution and dispersion in the pelagic environment. in *Proceedings of the Tenth Annual Work*, T.H. Richardson, J.I. Richardson, and M. Donnelly, eds. pp 111–114.

Collum, L. A. and T. H. Fritts, 1985. Sperm whales (*Physeter catodon*) in the Gulf of Mexico. *Southwestern Naturalist* 30(1):101–104.

Coltman, D. W., G. Stenson, M. O. Hammill, T. Haug, C. S. Davis, and T. L. Fulton, 2007. Panmictic population structure in the hooded seal (*Cystophora cristata*). *Molecular Ecology*, Vol 16, pp 1639–1648.

Comer, K. E., 2002. Habitat suitability index models for nesting sea turtles at the U.S. Naval Station Guantanamo Bay, Cuba. Master's thesis, San Diego State University.

Committee on Energy and Natural Resources (CENR), 2005. *The Future of Liquefied Natural Gas: Siting and Safety. Energy Hearing.* Testimony of Richard L. Grant. 15 February 2005. Retrieved from http://energy.senate.gov/hearings/testimony.cfm?id=1384&wit_id=4001, on 17 October 2007.

Committee on the Status of Endangered Wildlife in Canada (COSEWIC), 2003. COSEWIC assessment and status report on the humpback whale *Megaptera novaeangliae* in Canada. Ottawa, Ontario: Committee on the Status of Endangered Wildlife in Canada. viii, pp 25.

Committee on the Status of Endangered Wildlife in Canada (COSEWIC), 2004. *COSEWIC assessment and update status report on the beluga whale* Delphinapterus leucas *in Canada*. Ottawa, Ontario: Committee on the Status of Endangered Wildlife in Canada.

Committee on Toxicity, Ecotoxicity and the Environment (CSTEE), 2000. CSTEE opinion on BKH Consulting Engineers' report "Towards the establishment of a priority list of substances for further evaluation of their role in endocrine disruption." Opinion adopted at the 17th CSTEE plenary meeting, Brussels, 5 September 2000. Scientific Committee for Toxicity, Ecotoxicity and the Environment, European Commission. Retrieved from http://ec.europa.eu/health/ph_risk/committees/sct/sct_opinions_en.print.htm.

Congressional Research Service, 2003. Liquefied Natural Gas (LNG) Infrastructure Security: Background and Issues for Congress. Report for Congress. 9 September 2003. Retrieved from http://www.energy.ca.gov/lng/documents/CRS_RPT_LNG_INFRA_SECURITY.pdf, on 17 October 2007.

Connor, R. C., and Heithaus, M. R., 1996. Approach by great white shark elicits flight response in bottlenose dolphins. *Marine Mammal Science*, Vol 12, pp 602–606.

Continental Shelf Associates, Inc., 2004. Explosive removal of offshore structures -information synthesis report. U.S. Department of the Interior, Minerals Management Service, Gulf of Mexico OCS Region, New Orleans, LA. OCS Study MMS 2003-070. 181 pp., app.

Cook, M. L. H., C. A. Manire, and D. A. Mann, 2005. Auditory evoked potential (AEP) measurements in stranded rough-toothed dolphins (*Steno bredanensis*). *Journal of the Acoustical Society of America*, Vol 117, No 4, Part 2, p 2441.

Cook, M. L. H., L. S. Sayigh, J. E. Blum, and R. S. Wells, 2004. Signature-whistle production in undisturbed free-ranging bottlenose dolphins (*Tursiops truncatus)*. *Proceedings of the Royal Society B: Biological Sciences*, Vol 271, pp 1043–1049.

Cook, M. L. H., R. A. Varela, J. D. Goldstein, S. D. McCulloch, G. D. Bossart, J. J. Finneran, D. Houser, and D. A. Mann, 2006. Beaked whale auditory evoked potential hearing measurements. *Journal of Comparative Physiology A*, Vol 192, pp 489–495.

Cook, S. L. and T. G. Forrest, 2005. Sounds produced by nesting leatherback sea turtles (Dermochelys coriacea). *Herpetological Review*, Vol 36, No 4, pp 387–390.

Cook, S. L., and T. G. Forrest, 2005. Sounds Produced by Nesting Leatherback Sea Turtles (*Dermochelys coriacea*). *Herpetological Review*, Vol 36, No 4, pp 387–390.

Coombs, S., and A. N. Popper, 1979. Hearing differences among Hawaiian squirrelfish (family Holocentridae) related to differences in the peripheral auditory system. *Journal of Comparative Physiology*, Vol 132, pp 203–207.

Coombs, S., and J. C. Montgomery, 1999. The enigmatic leteral line system, in *Comparative Hearing: Fish and Amphibians*, R. R. Fay, and A. N. Popper, eds. pp 319–362. Springer-Verlag: New York.

Corkeron, P. J., and S. M. van Parijs, 2001. Vocalizations of eastern Australian Risso's dolphins, *Grampus griseus*. *Canadian Journal of Zoology*, Vol 79, pp 160–164.

Cortese, N. A., 2000. Delineation of bottlenose dolphin populations in the western Atlantic Ocean using stable isotopes. Master's thesis, University of Virginia.

Costa, D. P., D. E. Crocker, J. Gedamke, P. M. Webb, D S. Houser, S. B. Blackwell, D. Waples, S. A. Hayes and B. J. Le Boeuf, 2003. The effect of a low-frequency sound source (acoustic thermometry of the ocean climate) on the diving behavior of juvenile northern elephant seals, *Mirounga angustirostris*. *Journal of the Acoustical Society of America*, Vol 113, No 2, pp 1155–1165.

Cox, T. M., A. J. Read, S. G. Barco, J. Evans, D. P. Gannon, H. Koopman, W. A. McLellan, K. Murray, J. R. Nicolas, D. A. Pabst, C. W. Potter, W. M. Swingle, V. G. Thayer, K. M. Touhey, and A. J. Westgate, 1998. Documenting the bycatch of harbor porpoises, *Phocoena phocoena*, in coastal gillnet fisheries from stranded carcasses. *Fishery Bulletin*, Vol 96, pp 727–734.

Cox, T. M., T. J. Ragen, A. J. Read, E. Vos, R. W. Baird, K. Balcomb, J. Barlow, J. Caldwell, T. Ranford, L. Crum, A. D'amico, G. D'spain, A. Fernández, J. Finneran, R. Gentry, W. Gerth, F. Gulland, J. Hildebrand, D. Houser, T. Hullar, P. D. Jepson, D. Ketten, C. D. Macleod, P. Miller, S. Moore, D. C. Mountain, D. Palka, P. Ponganis, S. Rommel, T. Rowles, B. Taylor, P. Tyack, D. Wartzok, R. Gisiner, J. Meads, L. Benner, 2006. Understanding the impacts of anthropogenic sound on beaked whales. *Journal of Cetacean Research Management*, Vol 7, pp 177–187.

Cox, T. M., T. J. Ragen, A. J. Read, E. Vos, R. W. Baird, K. Balcomb, J. Barlow, J. Caldwell, T. Ranford, L. Crum, A. D'amico, G. D'spain, A. Fernández, J. Finneran, R. Gentry, W. Gerth, F. Gulland, J. Hildebrand, D. Houser, T. Hullar, P. D. Jepson, D. Ketten, C. D. Macleod, P. Miller, S. Moore, D. C. Mountain, D. Palka, P. Ponganis, S. Rommel, T. Rowles, B. Taylor, P. Tyack, D. Wartzok, R. Gisiner, J. Meads, L. Benner, 2006. Understanding the impacts of anthropogenic sound on beaked whales. *Journal of Cetacean Research Management*, Vol 7, pp 177–187.

Coyne, M. S., M. E. Monaco, A. M. Landry, Jr. 1998. Kemp's ridley habitat suitability index model. Slide Presentation: Eighteenth International Sea Turtle Symposium. 3–7 March 1998. Mazatlán, Sinaloa.

Coyne, M. S., M. E. Monaco, and A .M. Landry, Jr. 2000. Kemp's ridley habitat suitability index model. Page 60 in F.A. Abreu-Grobois, R. Briseño-Dueñas, R. Márquez-Millán and L. Sarti-Martínez, eds. Proceedings of the Eighteenth International Sea Turtle Symposium. NOAA Technical Memorandum NMFS-SEFSC-436.

Croll, D. A., A. Acevedo-Gutiérrez, B. R. Tershy, and J. Urbán-Ramírez, 2001. The diving behavior of blue and fin whales: Is dive duration shorter than expected based on oxygen stores? Comparative Biochemistry and Physiology, Part A 129:797–809.

Croll, D. A., C. W. Clark, A. Acevedo, B. Tershy, S. Flores, J. Gedamke, and J. Urban, 2002. Only male fin whales sing loud songs. *Nature*, Vol 417, p 809.

Crum, L. A., and Y. Mao, 1996. Acoustically enhanced bubble growth at low frequencies and its implications for human diver and marine mammal safety. *Journal of the Acoustical Society of America*, Vol 99, pp 2898–2907.

Crum, L. A., M.R. Bailey, G. Jingfeng, P.R. Hilmo, S.G. Kargl, and T.J. Matula. 2005. Monitoring bubble growth in supersaturated blood and tissue *ex vivo* and the relevance to marine mammal bioeffects. *Acoustic Research Letters Online*, Vol 6, pp 214–220.

Culik, B. M., 2002. Review on Small Cetaceans: Distribution, Behaviour, Migration and Threats, in United Nations Environment Programme, Convention on Migratory Species, *Marine Mammal Action Plan/Regional Seas Reports and Studies*, No 177, p 343.

Culik, B. M., S. Koschinski, N. Tregenza, and G.M. Ellis, 2001. Reactions of harbour porpoises (*Phocoena phocoena*) and herring (*Clupea harengus*) to acoustic alarms. *Marine Ecology Progress Series*, Vol 211, pp 255–260.

Cummings, W. C. and J. F. Fish, 1971. A synopsis of marine animal underwater sounds in eight geographic areas. Special report for NUC Code 14. San Diego, California: Naval Undersea Research and Development Center, Code 5054.

Cummings, W. C., 1985. Bryde's whale *Balaenoptera edeni* Anderson, 1878, in *Handbook of Marine Mammals, Vol 3: The Sirenians and Baleen Whales*, S. H. Ridgway and R. Harrison, eds. Academic Press: San Diego, California. pp 137–154.

Cummings, W. C., 1985. Bryde's whale *Balaenoptera edeni* Anderson, 1878. in *Handbook of marine mammals. Volume 3: The sirenians and baleen whales*, Ridgway, S.H. and R. Harrison, eds. Academic Press: San Diego, California. pp 137–154.

Curry, B. E., and J. Smith, 1997. Phylogeographic structure of the bottlenose dolphin (*Tursiops truncatus*): Stock identification and implications for management. Molecular genetics of marine mammals. *Society for Marine Mammalogy Special Publication 3*, D.E. Dizon, S.J. Chivers, and W.F. Perrin, eds. Lawrence, Kansas. pp 227–247.

D'Amico, A., and W. Verboom, 1998. Report of the Bioacoustics Panel, NATO/SACLANT, pp. 2-1–2-60.

D'Spain, G. L., A. D'Amico, and D. M. Fromm., 2006. Properties of the underwater sound fields during some well documented beaked whale mass stranding events. *Journal of Cetacean Research and Management*, Vol 7, No 3, pp 223–238.

D'Vincent, C. G., R. M. Nilson, and R. E. Hanna, 1985. Vocalization and coordinated feeding behavior of the humpback whale in southeastern Alaska. *Scientific Reports of the Whales Research Institute* Vol. 36, pp 41–47.

Dahlheim, M. E. and J. E. Heyning, 1999. Killer whale *Orcinus orca* (Linnaeus, 1758), in *Handbook of Marine Mammals. Volume 6: The second book of dolphins and the porpoises*, Ridgway, S.H. and R. Harrison, eds. Academic Press: San Diego, California. pp 281–322.

Dalebout, M. L., K. M. Robertson, A. Frantzis, D. Engelhaupt, A.A. Mignucci-Giannoni, R.J. Rosario-Delestre, and C.S. Baker, 2005. Worldwide structure of mtDNA diversity among Cuvier's beaked whales (*Ziphius cavirostris*): Implications for threatened populations. *Molecular Ecology*, Vol 14, pp 3353–3371.

Dalecki, D., S. Z. Child, and C. H. Raeman, 2002. Lung damage from exposure to low-frequency underwater sound. *Journal of the Acoustical Society of America*, Vol 111, pp 2462A.

Danton, C. and R. Prescott, 1988. Kemp's ridley in Cape Cod Bay, Massachusetts -1987 field research, in *Schroeder (Compiler), Proc. Eighth Ann .Workshop on Sea Turtle Conserv. and Biol*. pp. 17–18. Fort Fisher, NC. Feb. 1988.

Das, K., G. Lepoint, Y. Leroy, and J. M. Bouquegneau, 2003. Marine mammals from the southern North Sea: Feeding ecology data from $\delta^{13}C$ and $\delta^{15}N$ measurements. *Marine Ecology Progress Series*, Vol 263, pp 287–298.

Davenport, J. and G. H. Balazs, 1991. 'Fiery Bodies'—are Pyrosomas an Important Component of the Diet of Leatherback Turtles*?" British Herpetological Society Bulletin, Vol* 31, pp 33–38.

Davidson, P., 2007. Marine energy can be forecast. *USA Today*. Retrieved from http://www.usatoday.com/tech/science/2007-04-18-wave-power_N.htm, on 24 July 2007.

Davies, J. L., 1957. The geography of the gray seal. *Journal of Mammalogy*, Vol 38, No 3, pp 297–310.

Davis, R. W. and G. S. Fargion, eds., 1996a. *Distribution and abundance of cetaceans in the north-central and western Gulf of Mexico, final report. Volume II*: Technical report. OCS Study MMS 96-0027. New Orleans, Louisiana: Minerals Management Service.

Davis, R. W. and G. S. Fargion, eds., 1996b. *Distribution and abundance of cetaceans in the north-central and western Gulf of Mexico, Final report. Volume III: Appendix C, part 2 of 2*. OCS Study MMS 96-0028. New Orleans, Louisiana: Minerals Management Service.

Davis, R. W., G. A. J. Worthy, B. Würsig, and S. K. Lynn, 1996. Diving behavior and at-sea movements of an Atlantic spotted dolphin in the Gulf of Mexico. *Marine Mammal Science*, Vol 12, No 4, pp 569–581.

Davis, R. W., G. S. Fargion, N. May, T. D. Leming, M. Baumgartner, W. E. Evans, L. J. Hansen, and K. Mullin, 1998. Physical habitat of cetaceans along the continental slope in the north-central and western Gulf of Mexico. *Marine Mammal Science,* Vol 14, No. 3, pp 490–507.

Davis, R. W., J. G. Ortega-Ortiz, C. A. Ribic, W. E. Evans, D. C. Biggs, P. H. Ressler, R. B. Cady, R. R. Leben, K. D. Mullin, and B. Würsig, 2002. Cetacean habitat in the northern oceanic Gulf of Mexico. *Deep-Sea Research I*, Vol 49, pp 121–142.

Davis, R. W., W. E. Evans, and B. Würsig (eds.), 2000a. Cetaceans, sea turtles, and seabirds in the northern Gulf of Mexico: Distribution, abundance and habitat associations. Volume I: Executive Summary. USGS/BRD/CR – 1999-0006 and OCS Study MMS 2000-002. Minerals Management Service: New Orleans, Louisiana.

Davis, R. W., W. E. Evans, and B. Würsig, eds., 2000b. Cetaceans, sea turtles and seabirds in the northern Gulf of Mexico: Distribution, abundance and habitat associations. Volume 2: Technical report. USGS/BRD/CR-1999-0015 and OCS Study MMS 2000-003. New Orleans: Minerals Management Service.

Deecke, V. B., P. J. B. Slater, and J. K. B. Ford, 2002. Selective habituation shapes acoustic predator recognition in harbour seals. *Nature*, Vol 420, pp 171–173.

Department of Commerce and Department of the Navy (DON), 2001. *Joint Interim Report, Bahamas Marine Mammal Stranding Activity of 15–16 March 2000*. December 2001.

Department of Fisheries and Oceans (DFO), 2003. Atlantic seal hunt 2003-2004 management plan. Ottawa, Ontario: Fisheries and Oceans Canada.

Department of Fisheries and Oceans (DFO), 2005. Stock assessment of northwest Atlantic harp seals (*Pagophilus groenlandicus*). Canadian Science Advisory Secretariat Research Document 2005/037. Ottawa, Ontario: Department of Fisheries and Oceans.

Department of the Navy (DON), 1996. *Environmental Assessment of the Use of Selected Navy Test Sites for Development Tests and Fleet Training Exercises of the MK 48 Torpedoes.* Program Executive Office Undersea Warfare, Program Manager for Undersea Weapons. CONFIDENTIAL.

Department of the Navy (DON), 1998. *Final Environmental Impact Statement, Shock Testing the SEAWOLF Submarine*. Washington, D.C.: Naval Sea Systems Command.

Department of the Navy (DON), 1999. *Environmental Assessment/Overseas Environmental Assessment of the SH 60R Helicopter/ALFS Test Program*. Department of the Navy, PMA 299 Multi Mission Helicopter Programs Office, Patuxent River, Maryland.

Department of the Navy (DON), 2001. Department of the Navy, Chief of Naval Operations, *Final Overseas Environmental Impact Statement and Environmental Impact Statement for Surveillance Towed Array Sensor System Low Frequency Active (SURTASS LFA) Sonar*, January 2001.

Department of the Navy (DON), 2001a. *Environmental Impact Statement for the Shock Trial of the Winston S. Churchill, (DDG83)*. Department of the Navy. February 2001.

Department of the Navy (DON), 2001b. Office of Naval Research, *Final Environmental Impact Statement for the North Pacific Acoustic Laboratory (NPAL)," Volumes I and II*, January 2001.

Department of the Navy (DON), 2004a. Unveiling the Navy's range sustainment program: ensuring consistency and continued access for crucial Navy training areas. *Currents*, Winter 2004, pp 44–55. Retrieved from http://www.enviro-navair.navy.mil/currents/winter2004/Win04_Range_Sustainment.pdf.

Department of the Navy (DON), 2004b. *Navy Pre-Deployment Training at Eglin Air Force Base Final Environmental Assessment*. Atlantic Division, Naval Facilities Engineering Command, Norfolk, VA

Department of the Navy (DON), 2004c. *Essential Fish Habitat Assessment for Increased Explosive Charges Associated With Mine Warfare Training in the Panama City/Pensacola Naval Operating Areas*. Southern Division, Naval Facilities Engineering Command, North Charleston, South Carolina.

Department of the Navy (DON), 2004d. *Biological Assessment For Increased Explosive Charge Detonations Associated with Mine Warfare Training in the Panama City/Pensacola Naval Operating Areas*. Southern Division, Naval Facilities Engineering Command, North Charleston, South Carolina.

Department of Navy (DON), 2004e. *Report on the Results of the Inquiry into Allegations of Marine Mammal Impacts Surrounding the Use of Active Sonar by USS SHOUP (DDG 86) in the Haro Strait on or about 5 May 2003.* February 2004.

Department of the Navy (DON), 2005a. *Marine Resources Assessment for the Northeast Operating Areas: Atlantic City, Narragansett Bay, and Boston*. Atlantic Division, Naval Facilities Engineering Command, Norfolk, Virginia.

Department of the Navy (DON), 2006a. *U.S. Naval Mine Warfare Plan*, 4th ed. Retrieved from http://www.exwar.org/htm/ConceptDocs/Navy_USMC/MWP4thEd/millennium.htm. Retrieved from http://www.navy.mil/navydata/cno/n75/Htm/ConceptDocs/Navy_USMC/MWP4thEd/contents.htm, on 18 December 2006.

Department of the Navy (DON), 2006b. Notice of Intent to Prepare an Environmental Impact Statement, Overseas Environmental Impact Statement for Atlantic Fleet Active Sonar Training and to Announce Public Scoping Meetings. Published in the *Federal Register*, Vol 71, No. 189, on 29 September 2006.

Department of the Navy (DON), 2006c. *Notice of Extension of Public Scoping Period for the Intent to Prepare an Environmental Impact Statement, Overseas Environmental Impact Statement for Atlantic Fleet Active Sonar Training and to Announce Public Scoping Meetings*. Published in the *Federal Register*, Vol 71, No. 224, on 21 November 2006.

Department of the Navy (DON), 2006d. *Supplemental Comprehensive Overseas Environmental Assessment for Major Atlantic Fleet Training Exercises Occurring May 2007 Through May 2008*.

Department of the Navy (DON), 2006e. *Programmatic Overseas Environmental Assessment (OEA) for Sinking Exercises (SINKEX) in the Western North Atlantic Ocean.* Naval Undersea Warfare Center Division, Newport, November 2006.

Department of the Navy (DON), 2006f. Homeporting of Additional Surface Ships at Naval Station Mayport Environmental Impact Statement. Proposed Action and Alternatives Fact Sheet. Retrieved from http://mayporthome portingeis.com/Documents/Fact_Sheet_02_Proposed_Action_Alternatives.pdf, on 31 May 2007.

Department of the Navy (DON), 2006g. *2006 Supplement to the 2002 Rim of the Pacific (RIMPAC) Programmatic Environmental Assessment.* April 2006

Department of the Navy (DON), 2007. *Final Supplemental Environmental Impact Statement for Surveillance Towed Array Sensor System Low Frequency Active (SURTASS LFA). Sonar*. April.

Department of the Navy (DON), 2007a. *Navy OPAREA Density Estimate (NODE) for the Northeast OPAREAs: Boston, Narragansett Bay, and Atlantic City*. Prepared for the Department of the Navy, U.S. Fleet Forces Command, Norfolk, Virginia. Contract #N62470-02-D-9997, CTO 0030. Prepared by Geo-Marine, Inc., Hampton, Virginia.

Department of the Navy (DON), 2007b. *Navy OPAREA Density Estimate (NODE) for the Southeast OPAREAs: VACAPES, CHPT, JAX/XHASN, and Southeastern Florida & Autec-Andros*. Prepared for the Department of the

Navy, U.S. Fleet Forces Command, Norfolk, Virginia. Contract #N62470-02-D-9997, CTO 0030. Prepared by Geo-Marine, Inc., Hampton, Virginia.

Department of the Navy (DON), 2007c. *Navy OPAREA Density Estimate (NODE) for the GOMEX OPAREA. Prepared for the Department of the Navy, U.S. Fleet Forces Command, Norfolk, Virginia*. Contract #N62470-02-D-9997, CTO 0030. Prepared by Geo-Marine, Inc., Hampton, Virginia.

Department of the Navy (DON), 2007d. *Marine Resources Assessment for the Gulf of Mexico*. Prepared for the Department of the Navy, U.S. Fleet Forces Command, Norfolk, Virginia. Contract #N62470-02-D-9997, CTO 0030. Prepared by Geo-Marine, Inc., Hampton, Virginia.

Department of the Navy (DON), 2007e. *Programmatic Overseas Environmental Assessment (OEA) for MK 46, MK 54, and MK 48 Torpedo Exercises in waters off Cape Cod, Massachusetts*. June 2007.

Department of the Navy (DON), 2007f. *Final Comprehensive Report for the Operation of the Surveillance Towed Array Sensor System Low Frequency Active (SURTASS LFA) Sonar Onboard the R/V Cory Chouest and USNS IMPECCABLE (T-AGOS 23) Under the National Marine Fisheries Service Regulations 50 CFR 216 Subpart Q. National Marine Fisheries Service (NMFS)/National Oceanic and Atmospheric Administration (NOAA)*.

Department of the Navy (DON), 2007g. *Record of Negative Decision for Proposed Torpedo Exercises off Cape Cod, Massachusetts, 2007-2008*. 13 September 2007.

Department of the Navy (DON), 2007h. *Record of Decision for Surveillance Towed Array Sensor System Low Frequency Active (SURTASS LFA) Sonar Supplemental Environmental Impact Statement*. August.

Department of the Navy (DON), 2008a. Public Hearings for the Atlantic Fleet Active Sonar Training Draft Environmental Impact Statement/Overseas Environmental Impact Statement. Published in the *Federal Register*, Volume 73, No. 32, on 15 February 2008.

Department of the Navy (DON), 2008b. *Final Supplement to the Final Comprehensive Overseas Environmental Assessment for Major Atlantic Fleet Training Exercises*. April.

Department of the Navy (DON), 2008c. *Marine Mammal Research Investments FY 2004 – FY 2009*. Memorandum for Distribution, 2 May 2008.

Department of the Navy (DON), 2008d. *Virginia Capes Range Complex Draft Environmental Impact Statement/Overseas Environmental Impact Statement*. June 2008.

Department of the Navy (DON), 2008e. *Jacksonville Range Complex Draft Environmental Impact Statement/Overseas Environmental Impact Statement*. June 2008.

Department of the Navy (DON), 2008f. *Cherry Point Range Complex Draft Environmental Impact Statement/Overseas Environmental Impact Statement*. July 2008.

Department of the Navy (DON), 2008g. *Shock Trial of the MESA VERDE (LPD 19) Final EIS/OEIS*. May 2008.

Department of the Navy (DON), 2008h. *Overseas Environmental Assessment Air-to-Surface Bombing Exercises in the Northeast Range Complexes*. June 2008.

Department of the Navy (DON), 2008i. *Gulf of Mexico Range Complex Environmental Impact Statement/Overseas Environmental Impact Statement*, website. Retrieved from http://www.gomexrangecomplexeis.com/EIS.aspx, on August 2008.

Department of the Navy (DON), 2008j. *Draft Environmental Impact Statement/Overseas Environmental Impact Statement for NSWC PCD Mission Activities*. April 2008.

Department of the Navy (DON), 2008k. *Draft Overseas Environmental Impact Statement/ Environmental Impact Statement for Undersea Warfare Training Range*. December 2008.

Department of the Navy (DON), 2008l. *Draft Environmental Impact Statement for the Proposed Homeporting of Additional Surface Ships at Naval Station Mayport, FL*. March 2008.

Department of the Navy (DON), 2008m. *Marine Resources Assessment for the VACAPES Operating Area*. Prepared for the Department of the Navy, U.S. Fleet Forces Command, Norfolk, Virginia. Contract #N62470-02-D-9997, CTO 0030. Prepared by Geo-Marine, Inc., Hampton, Virginia.

Department of the Navy (DON), 2008n. *Marine Resources Assessment for the Cherry Point Operating Area*. Prepared for the Department of the Navy, U.S. Fleet Forces Command, Norfolk, Virginia. Contract #N62470-02-D-9997, CTO 0030. Prepared by Geo-Marine, Inc., Hampton, Virginia.

Department of the Navy (DON), 2008p. *Marine Resources Assessment for the Jacksonville/Charleston Operating Area*. Prepared for the Department of the Navy, U.S. Fleet Forces Command, Norfolk, Virginia. Contract #N62470-02-D-9997, CTO 0030. Prepared by Geo-Marine, Inc., Hampton, Virginia.

Department of Navy (DON), 2008q. *Final Hawaii Range Complex Environmental Impact Statement/Overseas Environmental Impact Statement.* May 2008.

Deslarzes, K. J. P. (ed.), 1998. *The Flower Garden Banks (Northwest Gulf of Mexico): Environmental Characteristics and Human Interaction*. OCS Report MMS 98-0010. U.S. Department of the Interior, Minerals Management Service, Gulf of Mexico OCS Region, New Orleans, Louisiana. pp 100.

DeSwart, R. L., P. S. Ross, J. G. Vos, and A. D. M. E. Osterhaus, 1996. Impaired immunity in harbour seals (*Phoca vitulina*) exposed to bioaccumulated environmental contaminants: Review of a long-term feeding study. *Environmental Health Perspectives*, Vol 104, Supplement 4, pp 823–828. August.

Deutsch, C. J., J. P. Reid, R. K. Bonde, D. E. Easton, H. I. Kochman, and T. J. O'Shea, 2003. Seasonal movements, migratory behavior, and site fidelity of West Indian manatees along the Atlantic coast of the United States. *Wildlife Monographs*, Vol 151, pp 1–77.

Di Iorio, L., M. Castellote, A. M. Warde, and C. W. Clark, 2005. Broadband sound production by feeding blue whales (*Balaenoptera musculus*). Page 74 in *Abstracts, Sixteenth Biennial Conference on the Biology of Marine Mammals*. December 12–16, 2005. San Diego, California.

Dickerson, D., M. Wolters, C. Theriot, and C. Slay, 2004. Dredging Impacts on Sea Turtles in the Southeastern USA: A Historical Review of Protection. U.S. Army Corps of Engineers. Retrieved from http://el.erdc.usace.army.mil/seaturtles/docs/2004WODCON-Dickerson.pdf, on May 31, 2007.

Dierauf, L. A., and F. M. D. Gulland, 2001. Marine Mammal Unusual Mortality Events, in *Marine Mammal Medicine*, L. A. Dierauf, and F. M. D. Gulland, eds. CRC Press: Boca Raton. pp 69–81.

Dietz, R., J. Teilmann, M.-P. H. Jørgensen, and M.V. Jensen, 2002. Satellite tracking of humpback whales in West Greenland. Roskilde, Denmark: National Environmental Research Institute Technical Report 411.

Diez, C. E., X. Vélez-Zuazo, and R. P. van Dam, 2003. Hawksbill turtles in seagrass beds. *Marine Turtle Newsletter*, Vol 102, pp 8–10.

DiGiovanni, R. A., Jr., K. F. Durham, J. N. Wocial, R. P. Pisciotta, R. Hanusch, A. M. Chaillet, A. D. Hallett, A. M. Sabrosky, and R. A. Scott, 2005. Rehabilitation and post release monitoring of a male Risso's dolphin (*Grampus griseus*) released in New York waters. Page 76 in Abstracts, Sixteenth Biennial Conference on the Biology of Marine Mammals. December 12–16, 2005. San Diego, California.

Dison, W. J. and F. J. Massey, Jr., 1969. *Introduction to statistical analysis*. McGraw-Hill, Inc. NY.

Ditton, R. B., and T. L. Baker, 1999. *Demographics, attitudes, management preferences, and cconomic impacts of sport divers using artificial reefs in offshore Texas waters*. Report prepared for the Texas Parks and Wildlife Department through a research contract with Texas A&M University, College Station, Texas.

Dodd, C. K., 1988. Synopsis of the biological data on the loggerhead sea turtle *Caretta caretta* (Linnaeus 1758). *U.S. Fish and Wildlife Service Biological Report*, Vol 88, No 14, pp 1–110.

Dodd, C. K., 1995. Marine turtles in the southeast in *Our Living Resources—A Report to the Nation on the Distribution, Abundance, and Health of U.S. Plants, Animals, and Ecosystems*, .T. LaRoe, ed. Washington, D.C.: *National Biological Service*. pp 121–123.

Doi, T., F. Kasamatsu, and T. Nakano. 1982. A simulation study on sighting survey of minke whales in the Antarctic. *Reports of the International Whaling Commission*, Vol 32, pp 919–928.

Doi, T., F. Kasamatsu, and T. Nakano. 1983. Further simulation studies on sighting by introducing both concentration of sighting effort by angle and aggregations of minke whales in the Antarctic. *Reports of the International Whaling Commission*, Vol 33, pp 403–412.

Dolphin, W. F.. 1987. Ventilation and dive patterns of humpback whales, *Megaptera novaeangliae*, on their Alaskan feeding grounds. *Canadian Journal of Zoology*, Vol 65, pp 83–90.

Domingo, M., S. Kennedy, and M-F. van Bressem, 2002. “Marine Mammal Mass Mortalities” in P. G. H. Evans and J. A. Raga eds., *Marine Mammals: Biology and Conservation*. pp 425–456. Kluwer Academic/Plenum Publishers: New York.

Dominion, 2007a. Dominion Cove Point, LNG, LP. Retrieved from http://www.dom.com/about/gas-transmission/covepoint/index.jsp, on 17 October 2007.

Dominion, 2007b. Dominion Cove Point Expansion Project. Retrieved from http://www.dom.com/about/gas-transmission/covepoint/expansion/index.jsp, on 17 October 2007.

Domjan, 1998. SSC San Diego Trained Bottlenose Dolphins ad Beluga Data Set.

Donovan, G. P., 1991. A review of IWC stock boundaries. *Reports of the International Whaling Commission* Special Issue 13, pp 39–68.

Dooley, J. K., 1972. Fishes associated with the pelagic *Sargassum* complex, with a discussion of the *Sargassum* community. *Contributions in Marine Science*, Vol 16, pp 1–32.

Downeast LNG, 2007. Downeast LNG Project Description. Retrieved from http://www.downeastlng.com, on 17 October 2007.

Dudley, M., 1992. First Pacific record of a hooded seal, *Cystophora cristata* Erxleben, 1777. *Marine Mammal Science*, Vol 8, pp 164–168.

Dudzinski, K. M., 1996. Communication and behavior in the Atlantic spotted dolphins (*Stenella frontalis*): Relationships between vocal and behavioral activities. Ph.D. diss., Texas A&M University.

Dufault, S., H. Whitehead, and M. C. Dillon, 1999. An examination of the current knowledge on the stock structure of sperm whales (*Physeter macrocephalus*). *Journal of Cetacean Research and Management*, Vol 1, No 1, pp 1–10.

Duffield, D. A., S. H. Ridgway, and L. H. Cornell, 1983. Hematology distinguishes coastal and offshore forms of dolphins (*Tursiops*). *Canadian Journal of Zoology*, Vol 61, pp 930–933.

Dunning, D. J., Q. E. Ross, P. Geoghegan, J. J. Reichle, J. K. Menezes, and J. K. Watson, 1992. Alewives avoid high-frequency sound. *North American Journal of Fisheries Management*, Vol 12, pp 407–416.

Dürbaum, J. and D. Künnemann-Thorsten, 2007. Biology of Copepods: An Introduction. *Habitats*. Retreived from http://www.uni-oldenburg.de/zoomorphology/Biologyintro.html, on December 3, 2007.

Dutton, D. L., P. H. Dutton, M. Chaloupkac and R. H. Boulond, (2005). Increase of a Caribbean leatherback turtle *Dermochelys coriacea* nesting population linked to long-term nest protection. *Biological Conservation*, Vol 126, pp 186–194.

D'Vincent, C.G., R.M. Nilson, and R.E. Hanna. 1985. Vocalization and coordinated feeding behavior of the humpback whale in southeastern Alaska. *Scientific Reports of the Whales Research Institute*, Vol 36, pp 41–47.

Eagle-Picher Industries, Inc., 2008. Lithium-Alloy Thermal Batteries, MSDS Safety Information. Retrieved from http://info.kauaicc.hawaii.edu/msds/files/cky/ckygg.html on November 5, 2008.

Eckert, K. L., 1987. Environmental unpredictability and leatherback sea turtle (*Dermochelys coriacea*) nest loss. *Herpetologica*, Vol 43, pp 315–323.

Eckert, K. L., and C. Luginbuhl, 1988. Death of a giant. *Marine Turtle Newsletters*, Vol 43, pp 2–3.

Eckert, K. L., S. A. Eckert, T. W. Adams, and A. D. Tucker, 1989. Inter-nesting migrations by leatherback sea turtles (*Dermochelys coriacea*) in the West Indies. *Herpetologica,* Vol 45, pp 190–194.

Eckert, S. A. 2006b. Personal communication via email between Dr. S. A. Eckert, WIDECAST, Beaufort, North Carolina, and Ms. Dagmar Fertl, Geo-Marine, Inc., Plano, Texas, on 20 June 2006.

Eckert, S. A., 2002. Distribution of juvenile leatherback sea turtle *Dermochelys coriacea* sightings. *Marine Ecology Progress Series*, Vol 230, pp 289–293.

Eckert, S. A., 2006. high-use oceanic areas for Atlantic leatherback sea turtles (*Dermochelys coriacea*) as identified using satellite temetered location and dive information. *Marine Biology,* Vol 149, No 5, pp 1257–1267.

Eckert, S. A., D. Bagley, S. Kubis, L. Ehrhart, C. Johnson, K., Steweart, and D. DeFreese, 2006. Internesting and postnesting movements and foraging habitats of leatherback sea turtles (*Dermochelys coriacea*) nesting in Florida. *Chelonian Conservation and Biology,* Vol 5, No 2, 239–248.

Edds-Walton, P. L., 1997. Acoustic communication signals of mysticete whales. *Bioacoustics*, Vol 8, pp 47–60.

Edds-Walton, P. L., 2000. Vocalizations of minke whales *Balaenoptera acutorostrata* in the St. Lawrence Estuary. Bioacoustics, Vol 11, pp 31–50.

Egner, S. A., and D. A. Mann, 2005. Auditory sensitivity of sergeant major damselfish (*Abudefduf saxatilis*) from post-settlement juvenile to adult. *Marine Ecology*, Progressive Series, Vol 285, pp 213–222.

Eguchi, T. and J. T. Harvey. 2005. Diving behavior of the Pacific harbor seal (*Phoca vitulina richardii*) in Monterey Bay, California. *Marine Mammal Science*, Vol 21, No 2, pp 283–295.

Encalada, S. E., K. A. Bjorndal, A. B. Bolten, J. C. Zurita, B. Schroeder, E. Possardt, C. J. Sears, and B. W. Bowen, 1998. Population Structures of Loggerhead Turtle (*Caretta caretta*) Nesting Colonies in the Atlantic and Mediterranean as Inferred from Mitochondrial DNA Control Region Sequences. *Marine Biology*, Vol 130, pp 567–573.

Energy Information Administration, Office of Oil and Gas, 2005. *Overview of U.S. legislation and Regulations Affecting Offshore natural Gas and Oil Activity*. September 2005.

Engelhard, G. H., S. M. J. M. Brasseur, A. J. Hall, H. R. Burton, and P. J. H. Reijnders, 2002. Adrenocortical responsiveness in southern elephant seal mothers and pups during lactation and the effect of scientific handling. *Journal of Comparative Physiology – B*, Vol 172 pp 315–328.

Environment News Service (ENS), 2000. World's First Wave Generated Power Station Opens. Retrieved from http://www.climateark.org/articles/2000/4th/wofiwave.htm, on 24 July 2007.

Environmental Sciences Group (ESG), 2005. *Canadian Forces Maritime Experimental and Test Ranges Environmental Assessment Update*. Royal Military College of Canada.

Epperly, S. P., J. Braun, A. J. Chester, F. A. Cross, J. V. Merriner, and P. A. Tester, 1995b. Winter Distributions of Sea Turtles in the Vicinity of Cape Hatteras and Their Interactions With the Summer Flounder Trawl Fishery. *Bulletin of Marine Science*, Vol 56, p 547

Epperly, S. P., J. Braun, and A. J. Chester. 1995a. Aerial Surveys for Sea Turtles in North Carolina Inshore Waters. *Fishery Bulletin*, Vol 93, pp 254–261.

Epperly, S. P., J. Braun, and A. Veishlow, 1995. Sea turtles in North Carolina waters. *Conservation Biology*, Vol 9, pp 384–394.

Epperly, S. P., M. L. Snover, J. Braun-McNeill, W. N. Witzell, C. A. Brown, L. A. Csuzdi, W. G. Teas, L. B. Crowder, and R. A. Myers, 2001. Stock assessment of loggerhead sea turtles of the western north Atlantic. NOAA Technical Memorandum NMFS-SEFSC-455:3–66.

Erbe, C., 2000. Detection of whale calls in noise: Performance comparison between a beluga whale, human listeners, and a neural network. *Journal of the Acoustical Society of America*, Vol 108, pp 297–303.

Erdman, D. S., 1970. Marine mammals from Puerto Rico to Antigua. *Journal of Mammalogy*, Vol 51, No 3, pp 636–639.

Ernst, C. H., R. W. Barbour, and J. E. Lovich, 1994. *Turtles of the United States and Canada*. Smithsonian Institution Press, Washington, D.C.

Esher, R. J., C. Levenson, and T. D. Drummer, 1992. *Aerial surveys of endangered and protected species in the Empress II ship trial operating area in the Gulf of Mexico*. Final report. NRL/MR/7174-92-7002. Stennis Space Center, Mississippi: Naval Research Laboratory.

Evans, D. L. and L. A. Miller, 2003. Proceedings of the Workshop on Active Sonar and Cetaceans. *European Cetacean Society Newsletter*, No. 42 - *Special Issue, Las Palmas, Gran Canaria*.

Evans, D. L., and G. R. England, 2001. *Joint Interim Report Bahamas Marine Mammal Stranding Event of 15-16 March 2000*, Department of Commerce, pp 1–66.

Evans, G. H., and L. A. Miller, 2004. Proceedings of the Workshop on Active Sonar and Cetaceans. *European Cetacean Society Newsletter*, No. 42 Special Issue, February 2004.

Evans, W. E. 1994, Common dolphin, white-bellied porpoise *Delphinus delphis* Linnaeus, 1758, in *Handbook of Marine Mammals, Vol 5: The first book of dolphins*, S.H. Ridgway and R. Harrison, eds. San Diego, California: Academic Press. pp 191–224.

Excelerate Energy, 2008. Gulf Gateway Deepwater Port. Retrieved from http://www.excelerateenergy.com/gulfgateway.html, on 4 December 2008.

Fahlman, A., A. Olszowka, B. Bostrom, and D. R. Jones, 2006. Deep diving mammals: dive behavior and circulatory adjustments contribute to bends avoidance. *Respiratory Physiology & Neurobiology*, Vol 153, pp 66–77.

Fay, F. H., 1981. Walrus *Odobenus rosmarus* (Linnaeus, 1758). in *Handbook of Marine Mammals, Vol 1: The Walrus, Sea Lions, Fur Seals and Sea Otter*, S.H. Ridgway and R. Harrison, eds. San Diego: Academic Press. p 1–23.

Fay, R. R., 1988. *Hearing in Vertebrates, A Psychophysics Databook*. Hill-Fay Associates: Winnetka, Illinois.

Fazioli, K. L., S. Hofmann, and R. S. Wells, 2006. Use of Gulf of Mexico coastal waters by distinct assemblages of bottlenose dolphins (*Tursiops truncatus)*. *Aquatic Mammals*, Vol 32, No 2, pp 212–222.

Federal Aviation Administration (FAA), 2007. Air Route Traffic Control Centers. Retrieved from http://www.faa.gov/about/office_org/headquarters_offices/ato/artcc/, on 2 July 2007.

Federal Energy Regulatory Commission (FERC), 2005. Citizen's Guide-LNG Overview. Retrieved from http://www.ferc.gov/for-citizens/citizens-guides/lng.asp, on 22 May 2007.

Federal Energy Regulatory Commission (FERC), 2006a. Industries: LNG-Laws and Regulations. Retrieved from http://www.ferc.gov/industries/lng/gen-info/laws-regs.asp, on 22 May 2007.

Federal Energy Regulatory Commission (FERC), 2006b. Order Issuing Certificates and Granting Section 3 Authority. 16 June 2006. Retrieved from http://www.dom.com/about/gas-transmission/ covepoint/expansion/pdf/covepointexp_order.pdf, on 17 October 2007.

Federal Energy Regulatory Commission (FERC), 2007. Existing and Proposed North American LNG Terminals. Retreived from http://www.ferc.gov/industries/lng/indus-act/terminals/exist-prop-lng.pdf, on 22 May 2007.

Federal Energy Regulatory Commission, 2008. Notice of Intervention and Protest of the U.S. Department of the Interior for Ocean Renewable Power Company, LLC Ft. Lauderdale OCGen Power Project and West Palm Beach Power Project. Docket Numbers P-12498 and P-12500.

Feller, W. , 1968. *Introduction to probability theory and its application*, John Wiley & Sons, Vol 1. 3rd ed. New York, NY.

Fent, K., 2002. Ecotoxicological problems associated with contaminated sites. *Toxicology Letters*, Vols 140-141, No 2003, pp 353–365.

Fernández, A., J. F. Edwards, F. Rodriguez, A. Espinosa de los Monteros, P. Herraez, P. Castro, J. R. Jaber, V. Martin, and M. Arbelo, 2005. Gas and fat embolic syndrome involving a mass stranding of beaked whales (Family Ziphiidae) exposed to anthropogenic sonar signals, *Veterinary Pathology*, Vol 42, pp 446–457.

Fertl, D., A. J. Schiro, G. T. Regan, C. A. Beck, N. Adimey, L. Price-May, A. Amos, G. A. J. Worthy, and R. Crossland, 2005. Manatee occurrence in the northern Gulf of Mexico, west of Florida. *Gulf and Caribbean Research*, Vol 17, pp 69–94.

Fertl, D., T. A. Jefferson, I.B. Moreno, A. N. Zerbini, and K. D. Mullin, 2003. Distribution of the Clymene dolphin *Stenella clymene*. *Mammal Review*, Vol 33, No 3, pp 253–271.

Fiedler, P.C., 2002. Ocean environment, in *Encyclopedia of marine mammals*, W.F. Perrin, B. Würsig, and J.G.M. Thewissen, eds. Academic Press: San Diego, California. pp 824–830.

Finneran, J. J. and D. S. Houser, 2006. Comparison of in-air evoked potential and underwater behavioral hearing thresholds in four bottlenose dolphins (*Tursiops truncatus*). *Journal of the Acoustical Society of America*, Vol 119, No 5, pp 3181–3192.

Finneran, J. J., and C. E. Schlundt, 2004. *Effects of Intense Pure Tones on the Behavior of Trained Odontocetes. SPAWAR Systems Center, San Diego, California*. September 2003.

Finneran, J. J., C. E. Schlundt, B. Branstetter, and R. L. Dear, 2007. Assessing temporary threshold shift in a bottlenose dolphin (*Tursiops truncatus*) using multiple simultaneous auditory evoked potential. *Journal of the Acoustical Society of America*, Vol 122, pp 1249–1264.

Finneran, J. J., C. E. Schlundt, D. A. Carder, J. A. Clark, J. A. Young, J. B. Gaspin, and S. H. Ridgway, 2000. Auditory and behavioral responses of bottlenose dolphins (*Tursiops truncatus*) and a beluga whale (*Delphinapterus leucas*) to impulsive sounds resembling distant signatures of underwater explosions. *Journal of the Acoustical Society of America*, Vol 108, No 1, pp 417–431.

Finneran, J. J., D. A. Carder, and S. H. Ridgway, 2001. Temporary threshold shift (TTS) in bottlenose dolphins (*Tursiops truncatus*) exposed to tonal signals. 142nd Meeting of the Acoustical Society of America, Fort Lauderdale, Florida, December 2001. *Journal of the Acoustical Society of America*, Vol 110, No 5, p 2749(A).

Finneran, J. J., D. A. Carder, and S. H. Ridgway, 2003. Temporary threshold shift (TTS) measurements in bottlenose dolphins (*Tursiops truncatus*), belugas (*Delphinapterus leucas*), and California sea lions (*Zalophus californianus*). Environmental Consequences of Underwater Sound (ECOUS) Symposium, San Antonio, Texas. 12–16 May 2003.

Finneran, J. J., D. A. Carder, C. E. Schlundt, and S. H. Ridgway, 2005. Temporary threshold shift in bottlenose dolphins (*Tursiops truncatus*) exposed to mid-frequency tones. *Journal of the Acoustical Society of America*, Vol 118, pp 2696–2705.

Finneran, J. J., R. Dear, D. A. Carder, and S. H. Ridgway, 2002. Temporary shift in masked hearing thresholds in odontocetes after exposure to single underwater impulses from a seismic watergun. *Journal of the Acoustical Society of America*, Vol 111, No 6, pp 2929–2940.

Fish, J. F. and C. W. Turl, 1976. Acoustic source levels of four species of small whales. NUC TP 547. San Diego, California: Naval Undersea Center. 14 pp.

Fleming, E. H., 2001. Swimming against the tide: Recent surveys of exploitation, trade, and management of marine turtles in the northern Caribbean. TRAFFIC North America: Washington, D.C.

Flewelling, L. J., J. P. Naar, J. P. Abbott, D. G. Baden, N. B. Barros, G. D. Bossart, M.-Y. D. Bottein, D.G. Hammond, E.M. Haubold, C. A. Heil, M. S. Henry, H. M. Jacocks, T. A. Leighfield, R. H. Pierce, T. D. Pitchford, S. A. Rommel, P. S. Scott, K. A. Steidinger, E. W. Truby, F. M. Van Dolah, and J. H. Landsberg, 2005. Red tides and marine mammal mortalities. *Nature*, Vol 435, pp 755–756.

Florida Department of Environmental Protection (FDEP), 2007. Northwest District Envirofact: Sargassum Seaweed. Retrieved from http://www.dep.state.fl.us/northwest/Ecosys/waterquality/envirofact1.htm, on 19 June 2007.

Florida Fish and Wildlife Conservation Commission (FWC), 2005. 2005 Sea Turtle Strandings (Species and County). Accessed from http://research.myfwc.com/engine/download_redirection_process.asp?file= stbyco2005_1240.pdf&objid=23525&dltype=article, on 8 January 2008.

Florida Fish and Wildlife Conservation Commission (FWC), 2007. 370.12 Marine animals; Regulation – Protection of Marine Turtles. Retreived from http://myfwc.com/seaturtle/Rules/37012.htm, on 8 January 2008.

Florida Marine Research Institute (FMRI), 2006. Manatee synoptic surveys. Retrieved from. http://research.myfwc.com/features/print_article.asp?id=15246, on 20 October 2006

Foley, A. M., P. H. Dutton, K. E. Singel, A. E. Redlow, and W. G. Teas, 2003. The first records of olive ridleys in Florida, USA. *Marine Turtle Newsletter*, Vol 101, pp 23–25.

Folkow, L. P., and A. S. Blix, 1999. Diving behaviour of hooded seals (*Cystophora cristata*) in the Greenland and Norwegian Seas. *Polar Biology*, Vol 22, pp 61–74.

Folkow, L. P., E. S. Nordoy, and A. S. Blix, 2004. Distribution and diving behaviour of harp seals (*Pagophilus groenlandicus*) from the Greenland Sea stock. *Polar Biology*, Vol 27, pp 281–298.

Foote, A. D., R. W., Osborne, and A. Rus Hoelzel, 2004. Whale-call response to masking boat noise. *Nature*, pp 248:910.

Foote, J. J., and T. L. Mueller, 2002. *Two Kemp's ridley (Lepidochelys kempii) nests on the central Gulf coast of Sarasota County Florida (USA)*. Pages 252–253 in A. Mosier, A. Foley and B. Brost, eds. Proceedings of the Twentieth Annual Symposium on Sea Turtle Biology and Conservation. NOAA Technical Memorandum NMFS-SEFSC-477.

Ford, J. K. B., 1991. Vocal traditions among resident killer whales (*Orcinus orca*) in coastal waters of British Columbia. Canadian *Journal of Zoology*, Vol 69, pp 1454–1483.

Ford, J. K. B., 2002. Dialects, in *Encyclopedia of Marine Mammals*, Perrin, W.F., B. Würsig, and J.G.M. Thewissen, eds. Academic Press: San Diego, California. pp 322–323.

Forney, K. A. 2007. *Preliminary estimates of cetacean abundance along the U.S. West Coast and within four national marine sanctuaries during 2005*. NOAA Technical Memorandum NMFS-SWFSC-406:1–27.

Forney, K. A. and J. Barlow. 1993. Preliminary winter abundance estimates for cetaceans along the California coast based on a 1991 aerial survey. *Reports of the International Whaling Commission*, Vol 43, pp 407–415.

Forney, K. A., J. Barlow, and J. V. Carretta. 1995. The abundance of cetaceans in California waters. Part II: Aerial surveys in winter and spring of 1991 and 1992. *Fishery Bulletin*, Vol 93, No 1, pp 15–26.

Frankel, A. S., and C. W. Clark, 2000. Behavioral responses of humpback whales (*Megaptera novaeangliae*) to full-scale ATOC signals. *Journal of the Acoustical Society of America*, Vol 108, No 4, pp 1930–1937.

Frantzis, A., 1998. Does acoustic testing strand whales? *Nature*, p 29.

Frantzis, A., 1998. Does acoustic testing strand whales?, *Nature*, Vol 392, p 29.

Frantzis, A., J. C. Goold, E. K. Skarsoulis, M. I. Taroudakis, and V. Kandia, 2002. Clicks from Cuvier's beaked whales, *Ziphius cavirostris* (L). *Journal of the Acoustical Society of America*, Vol 112, No 1, pp 34–37.

Frantzis, A., and P. Alexiadou, 2008. Male sperm whale (*Physeter macrocephalis*) coda production and coda-type usage depend on the presence of conspecifics and the behavioral context. *Canadian Journal of Zoology*, Vol. 86, pp 62–75.

Frazier, J. G., 2001. General natural history of marine turtles, in *Proceedings: Marine Turtle Conservation in the Wider Caribbean Region: A Dialogue for Effective Regional Management*, K.L. Eckert and F.A. Abreu-Grobois, eds. 16–18 November 1999. Santo Domingo, Dominican Republic. p 3–17.

Frederick, P. C., and D. Siegel-Causey, 2000. Anhinga (*Anhinga anhinga*), in *The Birds of North America*, A. Poole and F. Gill, eds. No. 522. The Birds of North America, Inc., Philadelphia, PA.

Freitas, L., 2004. The stranding of three Cuvier's beaked whales *Ziphius cavirostris* in Madeira Archipelago - May 2000, in *European Cetacean Society 17th Annual Conference* (Las Palmas, Gran Canaria).

Frick, M. G., P. A. Mason, K. L. Williams, K. Andrews and H. Gerstung. 2003. Epibionts of Hawksbill Turtles, *Eretmochelys imbricata*, in a Caribbean Nesting Ground: A Potentially Unique Association with Snapping Shrimp. *Marine Turtle Newsletter*, Vol 99, pp 8–11.

Frick, M., 2001. Personal communication via email between Mr. Michael G. Frick, Caretta Research Project, Savannah, GA and Ms. Kristen Mazarella, Network for Endangered Sea Turtles, Kitty Hawk, NC, on 11 April 2001.

Frisch, S., 2006. Personal communication via e-mail between Dr. Stefan Frisch, University of South Florida, Tampa, Florida and Dr. Amy Scholk, Geo-Marine, Inc., Hampton, Virginia, on 11 January 2006.

Frisch, S., and K. Frisch, 2003. Low frequency vocalizations in the Florida manatee (*Trichechus manatus latirostris*), in *Abstracts, Fifteenth Biennial Conference on the Biology of Marine Mammals*. 14–19 December 2003. Greensboro, North Carolina. pp 55–56.

Fristrup, K.M, L.T. Hatch, and C.W. Clark, 2003. Variation in humpback whale (*Megaptera novaengliae)* song length in relation to low-frequency sound broadcast. *Journal of the Acoustical Society of America,* Vol 113, pp 3411–3424.

Fritts, T. H., A. B. Irvine, R. D. Jennings, L. A. Collum, W. Hoffman, and M. A. McGehee, 1983. *Turtles, birds, and mammals in the northern Gulf of Mexico and nearby Atlantic waters*. FWS/OBS-82/65. U.S. Fish and Wildlife Service Washington, D.C.

Fritts, T. H., W. Hoffman, and M. A. McGehee, 1983b. The Distribution and Abundance of Marine Turtles in the Gulf of Mexico and Nearby Atlantic Waters. *Journal of Herpetology*, Vol 17, pp 327–344.

Fromm, D., 2004a. Acoustic Modeling Results of the Haro Strait For 5 May 2003, Naval Research Laboratory Report, Office of Naval Research, 30 January 2004.

Fromm, D., 2004b. EEEL Analysis of Shoup Transmissions in the Haro Strait on 5 May 2003, Naval Research Laboratory briefing of 2 September 2004.

Frost, K. J., and L. F. Lowry. 1981. Ringed, Baikal and Caspian seals *Phoca hispida* Schreber, 1775; *Phoca sibirica* Gmelin, 1788 and *Phoca caspica* Gmelin, 1788. in *Handbook of Marine Mammals, Vol 2: Seals*. S.H. Ridgway and R. Harrison, eds. Academic Press: San Diego. pp 29–53.

Fullard, K. J., G. Early, M. P. Heide-Jørgensen, D. Bloch, A. Rosing-Asvid, and W. Amos, 2000. Population structure of long-finned pilot whales in the North Atlantic: A correlation with sea surface temperature? *Molecular Ecology*, Vol 9, pp 949–958.

Fulling, G. L., K. D. Mullin, and C. W. Hubard, 2003. Abundance and distribution of cetaceans in outer continental shelf waters of the U.S. Gulf of Mexico. *Fishery Bulletin*, Vol 101, pp 923–932.

G. S. Grant and D. Ferrell, 1993. Leatherback turtle, Dermochelys coriacea (*Reptilia: Dermochelidae*): notes on near-shore feeding behavior and association with cobia, Brimleyana 19, pp. 77–81.

Gabriele, C. and A. Frankel, 2002. The occurrence and significance of humpback whale songs in Glacier Bay, southeastern Alaska. *Arctic Research of the United States*, Vol 16, pp 42–47.

Gabriele, C., A. Frankel, and T. Lewis, 2001. *Frequent humpback whale songs recorded in Glacier Bay, Alaska in Fall 2000. in Abstracts, Fourteenth Biennial Conference on the Biology of Marine Mammals. 28 November - 3 December 2001*. Vancouver, British Columbia. pp 77–78.

Gailey, G., B. Würsig, and T. L. McDonald, 2007. Abundance, behavior, and movement patterns of western gray whales in relation to a 3-D seismic survey, Northeast Sakhalin Island, Russia. *Environmental Monitoring and Assessment*, Vol 134, pp 75–91.

Gambell, R., 1985. Fin whale *Balaenoptera physalus* (Linneaus, 1758), in *Handbook of Marine Mammals, Vol 3: The Sirenians and Baleen Whales*, Ridgway, S.H. and R. Harrison, eds. Academic Press: San Diego, California. pp 171–192.

Gambell, R., 1985. Fin whale *Balaenoptera physalus* (Linneaus, 1758), in *Handbook of Marine Mammals, Vol 3: The Sirenians and Baleen Whales*, S. H. Ridgway and R. Harrison, eds. Academic Press: San Diego, California. pp 171–192.

Gannier, A., 2000. Distribution of cetaceans off the Society Islands (French Polynesia) as obtained from dedicated surveys. *Aquatic Mammals*, Vol 26, No 2, pp 111–126.

Gannier, A., 2002. Cetaceans of the Marquesas Islands (French Polynesia): Distribution and relative abundance as obtained from a small boat dedicated survey. *Aquatic Mammals*, Vol 28, No 2, pp 198–210.

Gannon, D. P., N. B. Barros, D. P. Nowacek, A. J. Read, D. M. Waples, and R. S. Wells. 2005. Prey detection by bottlenose dolphins, *Tursiops truncatus*: An experimental test of the passive listening hypothesis. *Animal Behaviour*, Vol 69, pp 709–720.

Garduño-Andrade, M., V. Guzmán, E. Miranda, R. Briseñ0-Duenas, and F. A. Abreu-Grobois, 1999. Increases in hawksbill turtle (*Eretmochelys imbricate*) nesting in the Yucatán Peninsula, Mexico. 1977-1996: data in support of successful conservation? *Chelonian Conservation and Biology*, Vol 3, No 2, pp 286–295.

Garrison, E. G., C. P. Giammona, F. J. Kelly, A. R. Tripp, and G. A. Wolff, 1989. *Historic Shipwrecks and Magnetic Anomalies of the Northern Gulf of Mexico: Reevaluation of Archaeological Resource Management Zone Volume 1: Executive Summary*. 3 volumes. The Texas A&M Research Foundation, College Station, Texas. OCS Study/MMS 89-0024. U.S. Department of the Interior, Minerals Management Service, Gulf of Mexico OCS Region, New Orleans, Louisiana.

Garrison, L. and C. Yeung, 2001. Abundance estimates for Atlantic bottlenose dolphin stocks during summer and winter, 1995. Unpublished document prepared for the Take Reduction Team on Coastal Bottlenose Dolphins in the Western Atlantic.

Garrison, L. P., P. E. Rosel, A. Hohn, R. Baird, and W. Hoggard, 2003. Abundance of the coastal morphotype of bottlenose dolphin, *Tursiops truncatus*, in U.S. continental shelf waters between New Jersey and Florida during winter and summer 2002. Unpublished document prepared for the Take Reduction Team on Coastal Bottlenose Dolphins in the Western Atlantic.

Gaskin, D. E., 1982. *The ecology of whales and dolphins*. Portsmouth, New Hampshire: Heinemann.

Gaskin, D. E., 1987. Updated status of the right whale, *Eubalaena glacialis,* in Canada. *Canadian Field-Naturalist*, Vol 101, 2, pp 295–309.

Gaskin, D. E., 1991. An update on the status of the right whale, *Eubalaena glacialis*, in Canada. *Canadian Field-Naturalist* Vol 105, No 2, pp 198–205.

Gaskin, D. E., 1992. Status of the harbour porpoise, *Phocoena phocoena*, in Canada. *Canadian Field-Naturalist*, Vol 106, No 1, pp 36–54.

Gearin, P. J., M. E. Gosho, J. L. Lakke, L. Cooke, R. L. Delong, and K. M. Hughes, 2000. Experimental testing of acoustic alarms (pingers) to reduce bycatch of harbour porpoise, Phoceoena phocoena, in the state of Washington. *Journal of Cetacean Research and Management*, Vol 2, No 1, pp 1–9.

Gedamke, J., D. P. Costa, and A. Dunstan, 2001. Localization and visual verification of a complex minke whale vocalization. *Journal of the Acoustical Society of America*, Vol 109, No 6, pp 3038–3047.

Geo-Marine Incorporated, 2004. Letter from Dagmar Fertl, Geo-Marine Inc., to Eglin Air Force Base describing proposed Navy mine warfare training off Panama City and Pensacola, Florida, and the associated preparation of a Biological Assessment, Essential Fish Habitat Assessment, and an Environmental Assessment. March 3, 2004.

GEOTRACES, 2006. An international study of the marine biogeochemical cycles of trace elements and their isotopes. Scientific Committee on Oceanic Research. August.

Geraci, J. R., and V. J. Lounsbury, 2005. *Marine Mammals Ashore: A Field Guide fo Strandings*. Second Edition. National Aquarium in Baltimore, Baltimore, MD. pp 371.

Geraci, J. R., D. J. St. Aubin, I. K. Barker, R. G. Webster, V. S. Hinshaw, W. J. Bean, H. L. Ruhnke, J. H. Prescott, G. Early, A. S. Baker, S. Madoff, and R. T. Schooley. 1982. Mass mortality of harbor seals: Pneumonia associated with influenza A virus. *Science*, Vol 215, pp 1129–1131.

Geraci, J. R., Harwood, J., and Lounsbury, V. J., 1999. Marine mammal die-offs: Causes, investigations, and issues, in Conservation and management of marine mammals, edited by J. R. Twiss, and R. R. Reeves (Smithsonian Institution Press, Washington, DC), pp. 367–395.

Gerstein, E. R., L. Gerstein, S. E. Forsythe, and J. E. Blue, 1999. The underwater audiogram of the West Indian manatee (*Trichechus manatus*). *Journal of the Acoustical Society of America*, Vol 105, No 6, pp 3575–3583.

Gibbons, W., 2008. Do Turtle Excluder Devices Protect Sea Turtles? Ecoviews. Retrieved from http://www.uga.edu/srelherp/ecoview/Eco18.htm, on 23 May 2008.

Gilbert, J. R., and K. M. Wynne, 1985. *Harbor seal populations and fisheries interactions with marine mammals in New England, 1984*. Annual report to the National Marine Fisheries Service, Northeast Fisheries Science Center, Woods Hole, Massachusetts. Contracts NA-80-FA-C-00029 and NA-84-EA-C-00070. Orono, Maine: University of Maine.

Gilbert, J. R., and N. Guldager, 1998. Status of harbor and gray seal populations in northern New England. Prepared for the National Marine Fisheries Fisheries Service, Northeast Fisheries Science Center, Woods Hole, Massachusetts.

Gilbert, J. R., G. T. Waring, K. M. Wynne, and N. Guldager, 2005. Changes in abundance of harbor seals in Maine, 1981–2001. *Marine Mammal Science*, Vol 21, No 3, pp 519–535.

Gitschlag, G. R., and B. A. Herczeg, 1994. Sea turtle observations at explosive removals of energy structures. *Marine Fisheries Review*, Vol 56, No 2, p 1–8.

Gjertz, I., C. Lydersen, and Ø. Wiig, 2001. Distribution and diving of harbour seals (*Phoca vitulina*) in Svalbard. *Polar Biology*, Vol 24, pp 209–214.

Gjertz, I., K. M. Kovacs, C. Lydersen, and O. Wiig, 2000. Movements and diving of adult ringed seals (*Phoca hispida*) in Svalbard. *Polar Biology*, Vol 23, pp 651–656.

GlobalSecurity.org, 2005. Hampton Roads. Retrieve from http://www.globalsecurity.org/military/facility/ hampton-roads.htm, on 31 May 2007.

GlobalSecurity.org, 2007a. Patuxent River. Retrieve from http://www.globalsecurity.org/military/facility/ patuxent-river.htm, on 15 June 2007.

GlobalSecurity.org, 2007b. Cherry Point Marine Corps Air Station. Retrieve from http:// www.globalsecurity.org/military/facility/cherry-point.htm, on 15 June 2007.

GlobalSecurity.org, 2007c. Marine Corps Base Camp Lejeune. Retrieve from http://www.globalsecurity.org/military/facility/camp-lejeune.htm, on 15 June 2007.

GlobalSecurity.org, 2007d. SWFLANT, Kings Bay, Georgia. Retrieve from http://www.globalsecurity.org/wmd/facility/kings_bay.htm, on 15 June 2007.

GlobalSecurity.org, 2007e. Mayport Naval Station Jacksonville, Florida. Retrieve from http://www.globalsecurity.org/military/facility/mayport.htm, on 15 June 2007.

GlobalSecurity.org, 2007f. Boston Area Complex. Retrieve from http://www.globalsecurity.org/military/facility/moa-boston.htm, on 15 June 2007.

GlobalSecurity.org, 2007g. Naval Air Station Corpus Christi. Retrieve from http://www.globalsecurity.org/military/facility/corpus-christi.htm, on 15 June 2007.

Godfrey, D., 1996. Divine intervention? Kemp's ridley nests on Volusia County Beach. Velador *Caribbean Conservation Corporation Newsletter* (Summer), pp 1–2.

Godfrey, M., 2003. Not in Kansas anymore. Retrieved from http://www.seaturtle.org/blog/mgodfrey/ 2003_07.html, on 20 June 2006.

Godfrey, M., 2003. Not in Kansas Anymore. Sea Turtle.Org listserve communication by Mr. Matthew Godfrey. Retrieve from at http://www.seaturtle.org/blog/mgodfrey/2003_07.html, on 20 June 2006.

Goff, G. P., and J. Lien, 1988. Atlantic leatherback turtles, *Dermochelys coriacea*, in cold water off Newfoundland and Labrador. *Canadian Field-Naturalist*, Vol 102, No 1, pp 1–5.

Goodwin, G. G., 1954. Southern records for Arctic mammals and a northern record for Alfaro's rice rat. *Journal of Mammalogy*, Vol 35, No 2, pp 258.

Goodyear, J. D., 1993. A sonic/radio tag for monitoring dive depths and underwater movements of whales. *Journal of Wildlife Management*, Vol 57, No 3, pp 503–513.

Goold, J. C., 1996. Acoustic assessment of populations of common dolphin, *Delphinus delphis*, in conjunction with seismic surveying. *Journal of the Marine Biological Association*, UK, Vol 76, pp 811–820.

Goold, J. C., 1998. Acoustic assessment of populations of common dolphin off the west Wales coast with perspectives from satellite infrared imagery. *Journal of the Marine Biological Association*, UK. Vol 78, pp 1353–1364.

Goold, J. C., 2000. A diel pattern in vocal activity of short-beaked common dolphins, *Delphinus delphis*. *Marine Mammal Science*, Vol 16, No 1, pp 240–244.

Goulet, A., M. O. Hammill, and C. Barrette, 2001. Movements and diving of grey seal females (*Halichoerus grypus*) in the Gulf of St. Lawrence, Canada. *Polar Biology*, Vol 24, pp 432–439.

Govoni, J. J., L. R. Settle, and M. A. West, 2003. Trauma to juvenile pinfish and spot inflicted by submarine detonations. *Journal of Aquatic Animal Health*, Vol 15, pp 111–119.

Gowans, S., and L. Rendell, 1999. Head-butting in northern bottlenose whales (*Hyperoodon ampullatus*): A possible function for big heads? *Marine Mammal Science*, Vol 15, No 4, pp 1342–1350.

Gowans, S., H. Whitehead, J. K. Arch, and S. K. Hooker, 2000. Population size and residency patterns of northern bottlenose whales (*Hyperoodon ampullatus*) using the Gully, Nova Scotia. *Journal of Cetacean Research and Management*, Vol 2, No 3, pp 201–210.

Graziano, L., and G. Gawarkiewicz, 2005. Science corner – crossing the shelfbreak. *SEA Education Online Magazine: Following SEA*. Summer-Fall 2005 issue. Available at http://www.sea.edu/followingsea/9-05/f4_1_9-05.asp.

Green, L. M., G. Lewis, and P. Campbell, 2002. Trends in finfish landings of sport boat anglers in Texas marine waters, May 1974–May 1998. Management Data Series Number 204. Texas Parks and Wildlife Department Coastal Fisheries Division: Austin, Texas.

Gregory, J., and P. A. T. Clabburn, 2003. Avoidance behaviour of *Alosa fallax fallax* to pulsed ultrasound and its potential as a technique for monitoring clupeid spawning migration in a shallow river. *Aquatic Living Resources*, Vol 16.

Gregr, E. J., L. Nichol, J. K. B. Ford, G. Ellis, and A. W. Trites, 2000. Migration and population structure of northeastern Pacific whales off coastal British Columbia: An analysis of commercial whaling records from 1908–1967. *Marine Mammal Science*, Vol 16, No 4, pp 699–727.

Gregr, E., J. Calambokidis, L. Convey, J. Ford, I. Perry, L. Spaven, and M. Zacharias, 2005. Proposed recovery strategy for blue whales (*Balaenoptera musculus*), fin whales (*B. physalus*) and sei whales (*B. borealis*) in Pacific Canadian waters. Draft. Nanaimo, British Columbia: Fisheries and Oceans Canada.

Griffin, R. B. and N. J. Griffin, 2004. Temporal variation in Atlantic spotted dolphin (*Stenella frontalis*) and bottlenose dolphin (*Tursiops truncatus*) densities on the west Florida continental shelf. *Aquatic Mammals*, Vol 30, No 3, pp 380–390.

Griffin, R. B., and N. J. Griffin, 2003. Distribution, habitat partitioning, and abundance of Atlantic spotted dolphins, bottlenose dolphins, and loggerhead sea turtles on the eastern Gulf of Mexico continental shelf. *Gulf of Mexico Science*, Vol 2003, No 1, pp 23–34.

Grünkorn, T., A. Diederichs, and G. Nehls. 2005. Aerial surveys in the German Bight — estimating g(0) for harbour porpoises (Phocoena phocoena) by employing independent double counts. *European Cetacean Society Newsletter*, Vol 44 (Special Issue), pp 25–31.

Guinta, P., 2006. Whale's tail tells a tale. Retrieved from http://staugustine.com/stories/111606/news_4214734.shtml, on 16 November 2006.

Gulf of Mexico Fishery Management Council (GMFMC), 2007. Generic Amendments to Multiple Fishery Management Plans. Retrieved from http://www.gulfcouncil.org/Beta/GMFMCWeb/FMPs/generic_amendments.htm, on June 26, 2007 and July 2, 2007.

Gulf Restoration Network (GRN), 2007a. Every Fish Counts: Red Snapper. Retrieved from http://www.healthygulf.org/hot-issue/every-fish-counts-red-snapper.html, on 19 June 2007.

Gulf Restoration Network (GRN), 2007b. History. Retrieved from http://www.healthygulf.org/ history/history.html, on 19 June 2007.

Gulland, F. M. D., 2006. *Review of the Marine Mammal Unusual Mortality Event Response Program of the National Marine Fisheries Service*. Report to the Office of Protected Resources, NOAA/National Marine Fisheries Service, Silver Springs, MD. p 32.

Gulland, F. M. D., and A. J. Hall, 2005. The Role of Infectious Disease in Influencing Status and Trends, in *Marine Mammal Research*, J. E. Reynolds, W. F. Perrin, R. R. Reeves, S. Montgomery, and T. J. Ragen, eds. John Hopkins University Press: Baltimore. pp 47–61.

Gunter, G., 1954. Mammals of the Gulf of Mexico. *Fishery Bulletin*, Vol 55, pp 543–551.

Gurevich, V. S., 1980. Worldwide distribution and migration patterns of the white whale (beluga), *Delphinapterus leucas*. *Reports of the International Whaling Commission*, Vol 30, pp 465–480.

Guseman, J. L., and L. M. Ehrhart, 1990. Green turtles on sabellariid worm reefs: Initial results from studies on the Florida Atlantic coast. in *Proceedings of the Tenth Annual Workshop on Sea Turtle Biology and Conservation*, T. H. Richardson and M. Donnelly, eds. NOAA Technical Memorandum NMFS-SEFSC-278. pp 125–127.

Hain, J. H. W., M. J. Ratnaswamy, R. D. Kenney, and H. E. Winn, 1992. The fin whale, *Balaenoptera physalus*, in waters of the northeastern United States continental shelf. *Reports of the International Whaling Commission*, Vol 42, pp 653–669.

Hain, J. H. W., S. L. Ellis, R. D. Kenney, and C. K. Slay, 1999. Sightability of right whales in coastal waters of the southeastern United States with implications for the aerial monitoring program. Pages 191–207 in Garner, G.W., S.C. Amstrup, J.L. Laake, B.F.J. Manly, L.L. McDonald, and D.G. Robertson, eds. Marine mammal survey and assessment methods. Rotterdam, Netherlands: A.A. Balkema.

Hain, J. H. W., S. L. Ellis, R. D. Kenney, P. J. Clapham, B. K. Gray, M. T. Weinrich, and I. G. Babb, 1995. Apparent bottom feeding by humpback whales on Stellwagen Bank. *Marine Mammal Science*, Vol 11, No 4, pp 464–479.

Hall, A., 2002. Gray seal *Halichoerus grypus*, in *Encyclopedia of Marine Mammals*, Perrin, W.F., B. Würsig, and J.G.M. Thewissen, eds. San Diego, California: Academic Press. pp 522–524.

Hamazaki, T., 2002. Spatiotemporal prediction models of cetacean habitats in the mid-western North Atlantic Ocean (from Cape Hatteras, North Carolina, U.S.A. to Nova Scotia, Canada). *Marine Mammal Science*, Vol 18, No 4, pp 920–939.

Hameedi, M. J., A. S. Pait, and R. A.Warner, 2002. Environmental contaminant monitoring in the Gulf of Maine: A discussion papterpresented at the Northeast Coastal Monitoring Summit, Durham, NH, 10–12 December 2002. National Oceanic and Atmospheric Administration, Silver Springs, MD.

Hamilton, P. K. and C. A. Mayo, 1990. Population characteristics of right whales (*Eubalaena glacialis*) observed in Cape Cod and Massachusetts Bays, 1978–1986. *Reports of the International Whaling Commission*, Special Issue, Vol 12, pp 203–208.

Hammill, M. O. and G. B. Stenson, 2005. Abundance of Northwest Atlantic harp seals (1960–2005). DFO report. Research document 2005/090.

Hammill, M. O. and J. F. Gosselin, 1995. Grey seal (*Halichoerus grypus*) from the Northwest Atlantic: Female reproductive rates, age at first birth, and age of maturity in males. Canadian *Journal of Fisheries and Aquatic Sciences*, Vol 52, pp 2757–2761.

Hammill, M. O., G. B. Stenson, R. A. Myers, and W. T. Stobo, 1998. Pup production and population trends of the grey seal (*Halichoerus grypus*) in the Gulf of St. Lawrence. Canadian *Journal of Fisheries and Aquatic Sciences*, Vol 55, No 4, pp 430.

Hammill, M. O., J. F. Gosselin, G. B. Stenson, and V. Harvey, 2003. Changes in abundance of northwest Atlantic (Canadian) grey seals: Impacts of climate change? Page 67 in *Abstracts, Fifteenth Biennial Conference on the Biology of Marine Mammals*. pp 14–19 December 2003. Greensboro, North Carolina.

Haney J. C., and P. A. Mcgillivary, 1985. Aggregations of Cory's shearwaters (*Calonectris diomedea*) at gulf stream fronts. *Wilson Bulletin*, Vol 97, No 2, pp 191–200.

Haney, J. C., D. S. Lee, and R. D. Morris, 1999. Bridled Tern (*Sterna anaethetus*), .in *The Birds of North America*, A. Poole and F. Gill, eds. No. 468. The Birds of North America, Inc., Philadelphia, PA.

Hanggi, E. B. and R. J. Schusterman, 1994. Underwater acoustic displays and individual variation in male harbour seals, *Phoca vitulina*. *Animal Behaviour*, Vol 48, pp 1275–1283.

Hansen, L. J., K. D. Mullin, and C. L. Roden, 1994. *Preliminary Estimates of Cetacean Abundance in the Northern Gulf of Mexico, and of Selected Cetacean Species in the U.S. Atlantic Exclusive Economic Zone from Vessel Surveys*. Contribution Number MIA-93/94-58. Miami: *National Marine Fisheries Service*. pp 11.

Harington, C. R., 1966. Extralimital occurrences of walruses in the Canadian Arctic. *Journal of Mammalogy*, Vol 47, No 3, pp 506–513.

Harris, D. E., B. Lelli, and G. Jakush, 2002. Harp seal records from the southern Gulf of Maine: 1997–2001. *Northeastern Naturalist*, Vol 9, No 3, pp 331–340.

Harris, D. E., B. Lelli, G. Jakush, and G. Early, 2001. Hooded seal (*Cystophora cristata*) records from the southern Gulf of Maine. *Northeastern Naturalist*, Vol 8, No 4, pp 427–434.

Harrison, P., 1983. *Seabirds, An Identification Guide.* Houghton Mifflin: Boston.

Harwood, J., 2001. Marine mammals and their environment in the Twenty-First Century. *Journal of Mammalogy*, Vol 82, No 3, pp 630–640.

Hastings, M. C., A. N. Popper, J. J. Finneran, and P. J. Lanford, 1996. Effect of low frequency underwater sound on hair cells of the inner earand lateral line of the teleost fish *Astronotus ocellatus*. *J. Acoust. Soc. Am.*, Vol 99, pp 1759–1766.

Hastings, M., and A. Popper, 2005. *Effects of Sound on Fish.* Prepared under subcontract for Jones & Stokes on behalf of the California Department of Transportation, Contract No. 43A0139, Task Order 1. January 2005.

Hatch, J. J., and D. V. Weseloh, 1999. Double-crested Cormorant (*Phalacrocorax auritus*), in *The Birds of North America*, A. Poole and F. Gill, eds. No. 441. The Birds of North America, Inc., Philadelphia, PA.

Haviland-Howell, G., A.S. Frankel, C.M. Powell, A. Bocconcelli, R.L. Herman, and L.S. Sayigh, 2007. Recreational boating traffic: A chronic source of anthropogenic noise in the Wilmington, North Carolina Intracoastal Waterway. *The Journal of the Acoustical Society of America*, Vol 122, No 1, pp 160.

Hawkins, A. D., and A. D. F. Johnstone, 1978. The hearing of the atlantic salmon, *Salmo salar*. *Journal of Fish Biology*, Vol 13, pp 655–673.

Hays, G. C., C. R. Adams, A. C. Broderick, B. J. Godley, D. J. Lucas, J. D. Metcalfe, and A. A. Prior, 2000. The Diving Behaviour of Green Turtles at Ascension Island. *Animal Behavior Vol* 59, pp 577–586.

Hays, G. C., J. D. Houghton, and A. E. Myers, 2004. Pan-Atlantic leatherback turtle movements. *Nature*, Vol 429, pp 522.

Hazel, J., I. R. Lawler, H. Marsh, and S. Robson. 2007. Vessel speed increases collision risk for the green turtle Chelonia mydas Endangered Species Research, Vol 3, No 1, p 113.

Heimlich, S. L., D. K. Mellinger, S. L. Nieukirk, and C. G. Fox, 2005. Types, distribution, and seasonal occurrence of sounds attributed to Bryde’s whales (*Balaenoptera edeni*) recorded in the eastern tropical Pacific, 1999–2001. *Journal of the Acoustical Society of America*, Vol 118, No 3, pp 1830–1837.

Helweg, D. A., A. S. Frankel, J. R. Mobley, Jr., and L. M. Herman, 1992. Humpback whale song: Our current understanding. in *Marine Mammal Sensory Systems*, Thomas, J.A., R.A. Kastelein, and A.Y. Supin, eds. New York, New York: Plenum Press. pp 459–483.

Hennessy, M. B., Heybach, J. P., Vernikos, J., and Levine, S., 1979. Plasma corticosterone concentrations sensitively reflect levels of stimulus intensity in the rat, *Physiology and Behavior*, Vol 22, pp 821–825.

Henwood, T. A. and L. H. Ogren, 1987. Distribution and migrations of immature Kemp's ridley turtles (*Lepidochelys kempi*) and green turtles (*Chelonia mydas*) off Florida, Georgia, and South Carolina. *Northeast Gulf Science*, Vol 9, No 2, pp 153–159.

Henwood, T. A., 1987. Movements and seasonal changes in loggerhead turtle (*Caretta caretta*) aggregations in the vicinity of Cape Canaveral, Florida (1978–84). *Biological Conservation*, Vol. 40, No. 3, pp.191–202.

Henwood, T. A., and W. E. Stuntz, 1987. Analysis of sea turtle captures and mortalities during commercial shrimp trawling. Fish. *Bull*, Vol 85, No 4, pp 813–17.

Hersh, S. L. and D. K. Odell, 1986. Mass stranding of Fraser's dolphin, *Lagenodelphis hosei*, in the western North Atlantic. *Marine Mammal Science*, Vol 2, No 1, pp 73–76.

Hersh, S. L., and D. A. Duffield, 1990. Distinction between northwest Atlantic offshore and coastal bottlenose dolphins based on hemoglobin profile and morphometry, in *The Bottlenose Dolphin*, S. Leatherwood and R.R. Reeves, eds. Academic Press: San Diego. pp 129–139.

Herzing, D. L., 1996. Vocalizations and associated underwater behavior of free-ranging Atlantic spotted dolphins, *Stenella frontalis* and bottlenose dolphins, *Tursiops truncatus*. *Aquatic Mammals*, Vol 22, No 2, pp 61–79.

Herzing, D. L., 1997. The life history of free-ranging Atlantic spotted dolphins (*Stenella frontalis*): Age classes, color phases, and female reproduction. *Marine Mammal Science*, Vol 13, No 4, pp 576–595.

Heyning, J. E., 1989. Cuvier's beaked whale - *Ziphius cavirostris* (G. Cuvier, 1823), in *Handbook of Marine Mammals. Volume 4: River Dolphins and the Larger Toothed Whales*, Ridgway, S.H. and R. Harrison, eds. Academic Press: San Diego, California. pp 289–308.

Heyning, J. E., and W. F. Perrin, 1994. Evidence for two species of common dolphins (genus Delphinus) from the eastern North Pacific. *Contributions in Science, Natural History Museum of Los Angeles County*, Vol 44, pp 1–35.

Hiett, R., and J. W. Milon, 2002. *Economic Impact of Recreational Fishing and Diving Associated With Offshore Oil and Gas Structures in the Gulf of Mexico*. Department of Interior, Minerals Management Service Document, MMS Study 2002-010.

Higgs, D. M., 2005. Auditory cues as ecological signals for marine fishes. *Marine Ecology Progress Series*, Vol 287, pp 278–281.

Higgs, D. M., D. T. T. Plachta, A. K. Rollo, M. Singheiser, M. C. Hastings, and A. N. Popper, 2004. Development of ultrasound detection in American shad (*Alosa sapidissima*). *The Journal of Experimental Biology*, Vol 207, pp 155–163.

Hildebrand, J., 2005. Impacts of anthropogenic sound, in *Marine mammal research: Conservation beyond crisis*, Reynolds III, J.E., W.F. Perrin, R.R. Reeves, S. Montgomery, and T.J. Ragen, eds. Baltimore, Maryland: Johns Hopkins University Press. pp 100–123

Hillis-Starr, Z. M., R. Boulon, and M. Evans, 1998. Sea turtles of the Virgin Islands and Puerto Rico, in *Status and trends of the nation's biological resources*, M.J. Mac, P.A. Opler, C.E. Pucket Haecker and P.D. Doran, eds. Reston, Virginia: U.S. Geological Survey. pp 334–337

Hirth, H. F., 1997. Synopsis of the Biological Data on the Green Turtle *Chelonia mydas* (Linnaeus 1758). U.S. Department of the Interior, Fish and Wildlife Service, Washington, D.C. *Biological Report*, Vol 97, No 1, pp 120 p.

Hirth, H. F., and L. H. Ogren, 1987. Some aspects of the ecology of the leatherback turtle *Dermochelys coriacea* at Laguna Jalova, Costa Rica. NOAA Technical Report NMFS 56:1–14.

Hoelzel, A. R., C. W. Potter, and P. B. Best, 1998. Genetic differentiation between parapatric ‘nearshore’ and ‘offshore’ populations of the bottlenose dolphin. *Proceedings of the Royal Society B: Biological Sciences*, Vol 265, No 1, pp 7–1183.

Hohn, A. A., D. S. Rotstein, C. A. Harms, and B. L. Southall, 2006. Report on marine mammal unusual mortality event UMESE0501Sp: Multispecies mass stranding of pilot whales (*Globicephala macrorhynchus*), minke whale (*Balaenoptera acutorostrata*), and dwarf sperm whales (*Kogia sima*) in North Carolina on 15–16 January 2005. NOAA Technical Memorandum NMFS-SEFSC-537:1–222.

Holloway-Adkins, K. G., 2006. Juvenile green turtles (*Chelonia mydas*) foraging on a high-energy, shallow reef on the east coast of Florida, USA. Page 193 in *Abstract, Twenty-sixth Annual Symposium on Sea Turtle Biology and Conservation*. 3–8 April 2006. Island of Crete, Greece.

Holt, M. M. and R. J. Schusterman, 2007. Spatial release from masking of aerial tones in pinnipeds. *Journal of the Acoustical Society of America*, Vol 121, No 2, pp 1219–1225.

Hooker, S. K., and H. Whitehead, 2002. Click characteristics of northern bottlenose whales (*Hyperoodon ampullatus*). *Marine Mammal Science*, Vol 18, No 1, pp 69–80.

Hooker, S. K., and R. W. Baird, 1999. Deep-diving behaviour of the northern bottlenose whale, *Hyperoodon ampullatus* (Cetacea: Ziphiidae*). Proceedings of the Royal Society London, Part B*, Vol 266, pp 671–676.

Hoover, K., S. S. Sadove, and P. Forestell, 1999. Trends of harbor seal, *Phoca vitulina*, abundance from aerial surveys in New York waters: 1985–1999. Page 85 in *Abstracts, Thirteenth Biennial Conference on the Biology of Marine Mammals*. 28 November–3 December 1999. Wailea, Maui.

Hopkins-Murphy S. R., D. W. Owens, T. M. Murphy (2003) Chapter 5: Ecology of immature loggerheads on foraging grounds and adults in internesting habitat in the Eastern United States, in *Bolton AB, Witherington BE (eds) Loggerhead sea turtles. Smithsonian Institution*, Washington, DC, p 79–82

Horwood, J., 1987. The sei whale: Population biology, ecology, & management. New York, New York: Croom Helm in association with Methuen, Inc.

Horwood, J., 1990. Biology and exploitation of the minke whale. CRC Press: Boca Raton, Florida.

Houghton J. D. R., M. J. Callow, and G. C. Hays, 2003. Habitat utilization by juvenile hawksbill turtles (*Eretmochelys imbricata*, Linnaeus, 1766) around a shallow water coral reef. *Journal of Natural History*, Vol 37, No 1, pp 9–1280.

Houser, D. S., and Finneran, J. J., 2006. Variation in the hearing sensitivity of a dolphin population obtained through the use of evoked potential audiometry. *Journal of the Acoustical Society of America*, Vol 120, pp 4090–4099.

Houser, D. S., D. A. Helweg, and P. W. B. Moore, 2001. A bandpass filter-bank model of auditory sensitivity in the humpback whale. *Aquatic Mammals*, Vol 27, pp 82–91.

Houser, D. S., R. Howard, and S.H. Ridgway. 2001b. Can diving-induced tissue nitrogen supersaturation increase the chance of acoustically driven bubble growth in marine mammals? *Journal of Theoretical Biology* 213: 183–195.

Hoyt, E., 1995. The worldwide value and extent of whale watching. Bath, United Kingdom: Whale and Dolphin Conservation Society.

Hoyt, E., 2001. Whale Watching 2001: Worldwide Tourism Numbers, Expenditures and Expanding Socioeconomic Beneifts. International Fund for Animal Welfare: Yarmouth Port, Massachusetts.

Hoyt, E., 2007. A Blueprint for Dolphin and Whale Watching Development. *Report of the Humane Society International*, pp 28.

Hubard, C. W. and S. L. Swartz, 2002. *Gulf of Mexico Bottlenose Dolphin Stock Identification Workshop*. NOAA Technical Memorandum NMFS-SEFSC-473:1–51.

Hunter, W. C., G. Walker, S. Melvin, and J. Wheeler, 2006. Southeast United States Regional Waterbird Conservation Plan. September 2006.

Inter-Agency Committee on Marine Science and Technology (IACMST), 2006. *IACMST Working Group Report No. 6*. January 2006.

International Council for the Exploration of the Sea (ICES), 2005a. *Report of the Ad-hoc Group on the Impacts of Sonar on Cetaceans and Fish, 2nd edition*. International Council for the Exploration of the Sea. ICES AGISC CM 2005/ACE:06. 25 pp.

International Council for the Exploration of the Sea (ICES), 2005b. *Answer to DG Environment request on scientific information concerning impact of sonar activities on cetacean populations*. International Council for the Exploration of the Sea. 5 pp.

International Fund for Animal Welfare (IFAW), 1995. Report of the Workshop on the Scientific Aspects of Managing Whale Watching. Montecastello di Vibio, Italy: International Fund for Animal Welfare.

International Union of Pure and Applied Chemistry (IUPAC), 2006. National Institute of Standards and Technology Solubility Database. Retrieved from http://srdata.nist.gov/solubility/.

International Whaling Commission (IWC), 2001a. Report of the Workshop on Status and Trends of Western North Atlantic Right Whales. *Journal of Cetacean Research and Management*, Special Issue, Vol 2, pp 1–87.

International Whaling Commission (IWC), 2001b. Report of the Workshop on the Comprehensive Assessment of Right Whales: A worldwide comparison. *Journal of Cetacean Research and Management*, Special Issue, Vol 2, pp –60.

International Whaling Commission (IWC), 2002. Report of the Scientific Committee. Annex H: Report of the Sub-committee on the Comprehensive Assessment of North Atlantic humpback whales. *Journal of Cetacean Research and Management*, Vol 4 (supplement), pp 230–260.

International Whaling Commission (IWC), 2005. Classification of the Order Cetacea (whales, dolphins and porpoises). *Journal of Cetacean Research and Management*, Vol 7, No 1, pp xi–xii.

International Whaling Commission (IWC), 2007. Special permit catches since 1985. Retrieved from http://www.iwcoffice.org/_documents/table_permit.htm, Last updated, on 20 September 2007.

International Whaling Commission (IWC), 2008. Catch Limits and Catches Taken. Retrieved from http://www.iwcoffice.org/conservation/catches.htm, on 10 December 2008.

International Whaling Commission (IWC), 2008. Catch Limits and Catches Taken. Retrieved from http://www.iwcoffice.org/conservation/catches.htm, on 10 December 2008.

Irvine, A. B., M. D. Scott, R. S. Wells, and J. G. Mead, 1979. Stranding of the pilot whale, *Globicephala macrorhynchus*, in Florida and South Carolina. *Fishery Bulletin*, Vol 77, No 2, pp 511–513.

Iversen, R. T. B., 1967. Response of the yellowfin tuna (*Thunnus albacares*) to underwater sound. *Marine Bioacoustics*, Vol 2.

Iversen, R. T. B., 1969. Auditory thresholds of the scombrid fish *Euthynnus affinis*, with comments on the use of sound in tuna fishing. *FAO Fisheries Report No. 62*, Vol 3, pp 849–859.

IWC (International Whaling Commission). 1982. Report of the Special Meeting on Southern Hemisphere Minke Whales, Cambridge, 22–26 June 1981. *Reports of the International Whaling Commission*, Vol 32, No 6, pp –745.

Jacksonville Port Authority (JAXPORT), 2007. Harbor Deepening. Retreived from http:// www.jaxport.com/sea/g_harbor.cfm, on 14 June 2007.

Jacobsen, K. O., M. Marx, and N. Øien, 2004. Two-way trans-Atlantic migration of a North Atlantic right whale (*Eubalaena glacialis*). *Marine Mammal Science*, Vol 20, No 1, pp 161–166.

Jakush, G., 2004. Wooly makes waves in Maine. Lifelines in *A Marine Animal Lifeline Publication*, Spring, Vol 1.

James, M. C., and T. B. Herman. 2001. Feeding of Dermochelys coriacea on medusae in the northwest Atlantic. Chelonian Conservation and Biology, Vol 4, No 1, pp 202–205.

James, M. C., C. A. Ottensmeyer, and R. A. Myers. 2005b. Identification of high-use habitat and threats to leatherback sea turtles in northern waters: New directions for conservation. *Ecology Letters*, Vol 8, pp 195–201.

James, M. C., R. A. Myers, and C. A. Ottensmeyer. 2005a. Behaviour of leatherback sea turtles, Dermochelys coriacea, during the migratory cycle. *Proceedings of the Royal Society B: Biological Sciences*, Vol 272, pp 1547–1555.

James, M. C., S. A. Eckert, and R. A. Myers. 2005c. Migratory and reproductive movements of male leatherback turtles (Dermochelys coriacea). *Marine Biology*, Vol 147, No 8, pp 853.

Janik, V. M., 2000. Food-related bray calls in wild bottlenose dolphins *(Tursiops truncatus)*. *Proceedings of the Royal Society B: Biological Sciences*, Vol 267, pp 923–927.

Janik, V. M., L. S. Sayigh, and R. S. Wells, 2006. Signature whistle shape conveys identity information to bottlenose dolphins. *Proceedings of the National Academy of Sciences of the United States of America*, Vol 103, No 2, pp 8293–8297.

Jansen, G., 1998. Physiological effects of noise, in *Handbook of Acoustical Measurements and Noise Control, 3rd Edition*. Acoustical Society of America: New York.

Jaquet, N., D. Gendron, and A. Coakes, 2003. Sperm whales in the Gulf of California: Residency, movements, behavior, and the possible influence of variation in food supply. *Marine Mammal Science*, Vol 19, No 3, pp 545–562.

Jaquet, N., S. Dawson, and E. Slooten, 2000. Seasonal distribution and diving behaviour of male sperm whales off Kaikoura: Foraging implications. *Canadian Journal of Zoology*, Vol 78, No 4, pp 419.

Jaquet, N., S. Dawson, and E. Slooten. 1998. *Diving behaviour of male sperm whales: foraging implications*. International Whaling Commission, Scientific Committee Doc. SC/50/CAWS 38, 20 pp. + 5 figs.

Jefferson, T. A., and B. E. Curry, 2003. *Stenella clymene*. *Mammalian Species*, Vol 726, pp 1–5.

Jefferson, T. A., and N. B. Barros, 1997. *Peponocephala electra*. *Mammalian Species*, Vol 553, pp: 1–6.

Jefferson, T. A., and S. Leatherwood, 1994. *Lagenodelphis hosei*. *Mammalian Species*, Vol 470, pp 1–5.

Jefferson, T. A., 1996. Estimates of abundance of cetaceans in offshore waters of the northwestern Gulf of Mexico, 1992–1993. *Southwestern Naturalist*, Vol 41, No 3, pp 279–287.

Jefferson, T. A., 2002a. Personal communication via in-house meeting and e-mail between Dr. Thomas A. Jefferson, National Marine Fisheries Service-Southwest Fisheries Science Center, and Ms. Dagmar Fertl, Geo-Marine, Inc., Plano, Texas, April 8, August 27, September 2, and September 17.

Jefferson, T. A., 2002b. Rough-toothed dolphin *Steno bredanensis*. in Perrin, *Encyclopedia of Marine Mammals*, W.F., B. Würsig, and J.G.M. Thewissen, eds. San Diego, California: Academic Press. pp 1055–1059.

Jefferson, T. A., 2006. Personal communication via email between Dr. Thomas A. Jefferson, National Marine Fisheries Service, La Jolla, California, and Ms. Dagmar Fertl, Geo-Marine, Inc., Plano, Texas, on August 25 and October 25 2006.

Jefferson, T. A., and A. J. Schiro, 1997. Distribution of cetaceans in the offshore Gulf of Mexico. *Mammal Review*, Vol 27, No 1, pp 27–50.

Jefferson, T. A., and A. J. Schiro, 1997. Distribution of cetaceans in the offshore Gulf of Mexico. *Mammal Review*, Vol 27, No 1, pp 27–50.

Jefferson, T. A., D. K. Odell, and K. T. Prunier, 1995. Notes on the biology of the Clymene dolphin (*Stenella clymene*) in the northern Gulf of Mexico. *Marine Mammal Science*, Vol 11, No 4, pp 564–573.

Jefferson, T. A., M. A. Webber, and R. L. Pitman, 2008. *Marine Mammals of the World: A Comprehensive Guide to Their Identification*. Academic Press: San Diego, California.

Jefferson, T. A., R. L. Pitman, S. Leatherwood, and M. L. L. Dolar, 1997. Developmental and sexual variation in the external appearance of Fraser's dolphins (*Lagenodelphis hosei*). *Aquatic Mammals*, Vol 23, No 3, pp 145–153.

Jefferson, T. A., S. Leatherwood, and M.A. Webber, 1993. FAO species identification guide. Marine mammals of the world. Rome: Food and Agriculture Organization of the United Nations.

Jensen, A. S., and G. K. Silber, 2004. Large Whale Ship Strike Database. U.S. Department of Commerce, NOAA Technical Memorandum NMFS-OPR-25.

Jepson, P. D., M. Arbelo, R. Deaville, I. A. P. Patterson, P. Castro, J. R. Baker, E. Degollada, H. M. Ross, P. Herráez, A. M. Pocknell, F. Rodríguez, F. E. Howie, A. Espinosa, R. J. Reid, J. R. Jaber, V. Martin, A. A. Cunningham, and A. Fernández, 2003. Gas-bubble lesions in stranded cetaceans. *Nature*, Vol 425, pp 575.

Jepson, P. D., R. Deaville, I. A. P. Patterson, A. M. Pocknell, H. M. Ross, J. R. Baker, F. E. Howie, R. J. Reid, A. Colloff, and A. A. Cunningham, 2005. Acute and Chronic Gas Bubble Lesions in Cetaceans Stranded in the United Kingdom. *Vet Pathol*, Vol 42, pp 291–305.

Jérémie, S., A. Gannier, S. Bourreau, and J.C. Nicolas, 2006. Acoustic monitoring of cetaceans in territorial waters off La Martinique (FWI), Lesser Antilles: Global abundance and first description of *Kogia simus* vocalisations (November–December 2004). Page 91 in *Abstracts, Twentieth Annual Conference of the European Cetacean Society*. April 2–7, 2006. Gdynia, Poland.

Ji, Zhen-Gang, 2003. *Applied Physical Sciences in Minerals Management Service (MMS), Volume I: Why and How MMS Uses the Physical Sciences to Fulfill Its Environmental Goals*. Outer Continental Shelf Report, MMS 2003-051.

Jochens, A., D. Biggs, D. Engelhaupt, J. Gordon, N. Jaquet, M. Johnson, R. Leben, B. Mate, P. Miller, J. Ortega-Ortiz, A. Thode, P. Tyack, J. Wormuth, and B. Würsig, 2006. Sperm whale seismic study in the Gulf of Mexico, Summary Report, 2002–2004. OCS Study MMS 2006-034. New Orleans, Louisiana: Minerals Management Service.

Johnson, A., G. Salvador, J. Kenney, J. Robbins, S. Kraus, S. Landry, and P. Clapham, 2005. Fishing Gear Involved in Entanglements of Right and Humpback Whales. *Marine Mammal Science*, Vol 21(4), pp 635–645. October.

Johnson, C. S., 1971. Auditory masking of one pure tone by another in the bottlenosed porpoise, *J. Acoust. Soc. Am*,. 49, pp 1317–1318.

Johnson, M., P. T. Madsen, W. M. X. Zimmer, N. Aguilar de Soto, and P. L. Tyack, 2004. Beaked whales echolocate on prey. *Proceedings of the Royal Society B: Biological Sciences*, Vol 271, pp S383–S386.

Johnston, D. W., 2002. The effect of acoustic harassment devices on harbor porpoises (*Phocoena phocoena*) in the Bay of Fundy, Canada. *Biological Conservation*, Vol 108, pp 113–118.

Johnston, D.W., A.S. Friedlaender, L.G. Torres, and D.M. Lavigne, 2005. Variation in sea ice cover on the east coast of Canada from 1969 to 2002: Climate variability and implications for harp and hooded seals. *Climate Research*, Vol 29, pp 209–222.

Jones, G. J. and L. S. Sayigh, 2002. Geographic variation in rates of vocal production of free-ranging bottlenose dolphins. *Marine Mammal Science*, Vol 18, No 2, pp 374–393.

Jørgensen, C., C. Lydersen, O. Brix, and K. M. Kovacs, 2001. Diving development in nursing harbour seal pups. *Journal of Experimental Biology*, Vol 204, pp 3993–4004.

Jørgensen, R., K. K. Olsen, I. B. Falk-Petersen, and P. Kanapthippilai, 2005. *Investigations of potential effects of low frequency sonar signals on survival, development and behaviour of fish larvae and juveniles*. The Norwegian College of Fishery Science, University of Tromso, N-9037 Tromso Norway.

Kasamatsu, F. and G. G. Joyce. 1995. Current status of Odontocetes in the Antarctic. *Antarctic Science*, Vol 7, No 4, pp 365–379.

Kastak, D. and R. J. Schusterman, 1998. Low-frequency amphibious hearing in pinnipeds: Methods, measurements, noise, and ecology. *Journal of the Acoustical Society of America*, Vol 103, No 4, pp 2216–2228.

Kastak, D., B. L. Southall, R. J. Schusterman, and C. R. Kastak, 2005. Underwater temporary threshold shift in pinnipeds: Effects of noise level and duration. *Journal of the Acoustical Society of America*, Vol 118, No 5, pp 3154–3163.

Kastak, D., R. J. Schusterman, B. L. Southall, and C. J. Reichmuth, 1999. Underwater temporary threshold shift induced by octave-band noise in three species of pinniped. *Journal of the Acoustical Society of America*, Vol 106, No 2, pp 1142–1148.

Kastelein, R., 2007. Personal communication via email between Dr. Ron Kastelein, Sea Mammal Research Company, The Netherlands, and Ms. Dagmar Fertl, Geo-Marine, Inc., Plano, Texas, on 6 April 2007.

Kastelein, R. A., H. T. Rippe, N. Vaughn, N. M. Schooneman, W. C. Verboom, and D. DeHaan, 2000. The effects of acoustic alarms on the behavior of harbor porpoises (*Phocoena phocoena*) in a floating pen. *Marine Mammal Science*, Vol 16, No 1, pp 46–64. January 2000.

Kastelein, R. A., P. Bunskoek, M. Hagedoorn, W. W. L. Au, and D. de Haan, 2002. Audiogram of a harbor porpoise (*Phocoena phocoena*) measured with narrrow-band frequency-modulated signals. *Journal of the Acoustical Society of America*, Vol 112, No 1, pp 334–344.

Kastelein, R. A., M. Hagedoorn, W. W. L. Au, and D. de Haan, 2003. Audiogram of a striped dolphin (*Stenella coeruleoalba*). *Journal of the Acoustical Society of America*, Vol 113, No 2, pp 1130–1137.

Kastelein, R. A., W. C. Verboom, M. Muijsers, N. V. Jennings, and S. van der Heul, 2005. The influence of acoustic emissions for underwater data transmission on the behaviour of harbor porpoises (*Phocoena phocoena*) in a floating pen. *Marine Environmental Research*, Vol 59, pp 287–307.

Kastelein, R. A., N. Jennings, W. C. Verboom, D. de Haan, and N. M. Schooneman, 2006. Differences in the response of a striped dolphin (*Stenella coeruleoalba*) and a harbour porpoise (*Phocoena phocoena*) to an acoustic alarm. *Marine Environmental Research*, Vol 61, pp 363–378.

Kastelein, R., van der Heul, S., Verboom, W., Triesscheijn, R. J. V., and Jennings, N. V., 2006b. "The influence of underwater data transmission sounds on the displacement behaviour of captive harbour seals *(Phoca vitulina)*," *Marine Environmental Research*, Vol61, pp 19–39.

Kato, H., 2002. Bryde's whales *Balaenoptera edeni* and *B. brydei* in Perrin, *Encyclopedia of Marine Mammals*, W.F., B. Würsig, and J.G.M. Thewissen, eds. Academic Press: San Diego, California. pp 171–176.

Katona, S. K. and J. A. Beard, 1990. Population size, migrations and feeding aggregations of the humpback whale (*Megaptera novaeangliae*) in the western North Atlantic Ocean. *Reports of the International Whaling Commission*, Special Issue, Vol 12, pp 295–305.

Katona, S. K., B. Baxter, O. Brizier, S. D. Kraus, J. Perkins, and H. Whitehead, 1979. Identification of humpback whales by fluke photographs, in *Behavior of Marine Animals: Current Perspectives in Research, Vol 3: Cetaceans*, Winn, H. E. and B. L. Olla, eds. New York, New York: Plenum Press. pp 33–44.

Katona, S. K., J. A. Beard, P. E. Girton, and F. Wenzel, 1988. Killer whales (*Orcinus orca*) from the Bay of Fundy to the Equator, including the Gulf of Mexico. Rit Fiskideildar. Katona, S. K., V. Rough, and D. T. Richardson, 1993. A field guide to whales, porpoises, and seals from Cape Cod to Newfoundland. Washington, D.C.: Smithsonian Institution Press. *Journal of the Marine Research Institute Reykjavik*, Vol XI, pp 205–224.

Katona, S. K., S. A. Testaverde, and B. Barr, 1978. Observations on a white-sided dolphin, *Lagenorhynchus acutus*, probably killed in gill nets in the Gulf of Maine. *Fishery Bulletin*, Vol 76, No 2, pp 475–476.

Katona, S. K., V. Rough, and D. T. Richardson, 1993. *A Field Guide to Whales, Porpoises, and Seals from Cape Cod to Newfoundland*. Smithsonian Institution Press: Washington, D.C.

Keeler, J. S., 1976. Models for noise-induced hearing loss, in *Effects of Noise on Hearing*, Henderson et al., eds. Raven Press: New York. pp 361–381.

Keinath, J. A., and J. A. Musick, 1990. *Dermochelys coriacea* (Leatherback sea turtle) migration. Herpetological Review. 21(4): 92.

Keinath, J. A., and J. A. Musick. 1993. Internesting movements and behavior of a leatherback turtle, *Dermochelys coriacea*. *Copeia*, Vol 4, pp 1010–1017.

Keinath, J. A., J. A. Musick, and D. E. Barnard, 1996. *Abundance and distribution of sea turtles off North Carolina. OCS Study MMS 95-0024*. Prepared for the Minerals Management Service, Gulf of Mexico OCS Region by the Virginia Institute of Marine Science.

Keinath, J. A., J. A. Musick, and W. M. Swingle, 1991. First verfied record of the hawksbill sea turtle (*Eretmochelys imbricate*) in Virginia waters. *Catesbeiana*, Vol 11, No 2, pp 37–38.

Kellogg, R., 1928. What is known of the migrations of some of the whalebone whales. *Annual Report of the Smithsonian Institution*, 1928, pp 467–494.

Kenney, R. D., 1990. Bottlenose dolphins off the northeastern United States, in Leatherwood, in *The Bottlenose Dolphin*, S. and R.R. Reeves, eds. Academic Press: San Diego, California. pp 369–386.

Kenney, R. D. 2005. Personal communication via email between Dr. Robert Kenney, University of Rhode Island, and Mr. William Barnhill, Geo-Marine, Inc., Plano, Texas, on 24 February 2005.

Kenney, R. D. and H. E. Winn, 1986. Cetacean high-use habitats of the northeast United States continental shelf. *Fishery Bulletin,* Vol 84, No 2, pp 345–357.

Kenney, R. D., 2001. Anomalous 1992 spring and summer right whale (*Eubalaena glacialis*) distributions in the Gulf of Maine. *Journal of Cetacean Research and Management*, Special Issue, Vol 2, pp 209–223.

Kenney, R. D., 2002. North Atlantic, North Pacific, and southern right whales (*Eubalaena glacialis, E. japonica*, and *E. australis*) in *Encyclopedia of Marine Mammals*, eds. W. F. Perrin, B. Würsig, and H. Thewissen, pp 806–813. Academic Press: San Diego, California.

Kenney, R. D., and H. E. Winn, 1987. Cetacean biomass densities near submarine canyons compared to adjacent shelf/slope areas. *Continental Shelf Research*, Vol 7, pp 107–114.

Kenney, R. D., C. A. Mayo, and H. E. Winn, 2001. Migration and foraging strategies at varying spatial scales in western North Atlantic right whales: A review of hypotheses. *Journal of Cetacean Research and Management*, Special Issue, Vol 2, pp 251–260.

Kenney, R. D., G. P. Scott, T. J. Thompson, and H. E. Winn, 1997. Estimates of prey consumption and trophic impacts of cetaceans in the USA Northeast Continental Shelf ecosystem. *Journal of Northwest Atlantic Fishery Science*, Vol 22, pp 155–171.

Kenney, R. D., H. E. Winn, and M. C. Macaulay, 1995. Cetaceans in the Great South Channel, 1979–1989: Right whale (*Eubalaena glacialis*). *Continental Shelf Research*, Vol 15, No 3, pp 414.

Kenney, R. D., M. A. M. Hyman, and H. E. Winn, 1985. Calculation of standing stocks and energetic requirements of the cetaceans of the northeast United States outer continental shelf. NOAA Technical Memorandum NMFS-F/NEC-41:1–99.

Kenney, R. D., P. M. Payne, D. W. Heinemann, and H. E. Winn, 1996. Shifts in northeast shelf cetacean distributions relative to trends in Gulf of Maine/Georges Bank finfish abundance. in *The Northeast Shelf Ecosystem: Assessment, Sustainability, and Management*, Sherman, K., N. A. Jaworski, and T. J. Smayda, eds. Boston, Massachusetts: *Blackwell Science*, pp 169–196.

Kenyon T. N., 1996. Ontogenetic changes in the auditory sensitivity of damselfishes (*Pomacentridae*). *Journal of Comparative Physiology*, Vol 179, pp 553–561.

Ketten, D. R., 1992. The marine mammal ear: Specializations for aquatic audition and echolocation, in *The Evolutionary Biology of Hearing*, Webster, D.B., R.R. Fay, and A.N. Popper, eds. Berlin, Germany: Springer-Verlag. pp 717–750.

Ketten, D. R., 1997. Structure and function in whale ears. *Bioacoustics*, Vol 8, pp 103–135.

Ketten, D. R., 1998. *Marine mammal auditory systems: A summary of audiometric and anatomical data and its implications for underwater acoustic impacts*. NOAA Technical Memorandum NOAA-NMFS-SWFSC-256:1-74.

Ketten, D. R., 2000. Cetacean ears, in *Hearing by Whales and Dolphins,* W. W. L. Au, A. N. Popper, and R. R. Fay, eds.Springer, New York. pp 43–108.

Ketten, D. R., 2005. *Beaked Whale Necropsy Findings for Strandings in the Bahamas, Puerto Rico, and Madeira, 1999-2002*. Woods Hole Oceanographic Institution. Woods Hole, Massachusetts.

Ketten, D. R., Lien, J., and Todd, S., 1993. Blast injury in humpback whale ears: Evidence and implications (A). Journal of the Acoustical Society of America, Vol 94, pp 1849–1850.

Kingsley, M. C. S., 1998. Population index estimates for the St. Lawrence belugas, 1973 – 1995. *Marine Mammal Science*, Vol 17, No 2, pp 218.

Kingston, S. E. and P. E. Rosel, 2004. Genetic differentiation among recently diverged delphinid taxa determined using AFLP markers. *Journal of Heredity*, Vol 95, No 1, pp 1–10.

Kinzel, M. R., G. T. Pintos, and R. B. Gamboa, 2003. Home range and habitat analysis of green turtles, Chelonia mydas, in the Gulf of Mexico. Abstract, Twenty-Second Annual Symposium of Sea Turtle Biology and Conservation, 4–7 April, Miami, Florida.

Klatsky, L., R. Wells, and J. Sweeney, 2005. Bermuda's deep diving dolphins - Movements and dive behavior of offshore bottlenose dolphins in the Northwest Atlantic Ocean near Bermuda. Page 152 in *Abstracts, Sixteenth Biennial Conference on the Biology of Marine Mammals*. 12–16 December 2005. San Diego, California.

Klishin, V. O., V. V. Popov, and A. Ya. Supin, 2000. Hearing capabilities of a beluga whale, *Delphinapterus leucas*. *Aquatic Mammals*, Vol 26, pp 212–228.

Knowlton, A. R., 1997. *The regulation of shipping to protect North Atlantic right whales: Need and feasibility.* Major paper, University of Rhode Island.

Knowlton, A. R., and S.D. Kraus, 2001. Mortality and serious injury of northern right whales (*Eubalaena glacialis*) in the western North Atlantic Ocean. *Journal of Cetacean Research and Management*, Special Issue, Vol 2, pp 193–204.

Knowlton, A. R., J. B. Ring, and B. Russell, 2002. *Right Whale Sightings and Survey Effort in the Mid Atlantic Region: Migratory Corridor, Time Frame, and Proximity to Port Entrances*. Report submitted to NMFS Ship Strike Working Group.

Knowlton, A. R., J. Sigurjonsson, J. N. Ciano, and S. D Kraus, 1992. Long distance movements of North Atlantic right whales (*Eubalaena glacialis*). *Marine Mammal Science*, Vol 8, No 4, pp 397–405.

Knudsen, F. R., P. S. Enger, and O. Sand, 1992. Awareness reactions and avoidance responses to sound in juvenile Atlantic salmon, *Salmo salar*. *Journal of Fish Biology*, Vol 40, pp 523–534.

Knudsen, F. R., P. S. Enger, and O. Sand, 1994. Avoidance responses to low frequency sound in downstream migrating Atlantic salmon smolt, *Salmo salar*. *Journal of Fish Biology*, Vol 45, pp 227–233.

Kooyman, G. L., D. D. Hammond, and J. P. Schroeder, 1970. Brochogramks and tracheograms of seals under pressure. *Science*, Vol 169, pp 82–84.

Kopelman, A. H., and S. S. Sadove, 1995. Ventilatory rate differences between surface-feeding and non-surface-feeding fin whales (*Balaenoptera physalus*) in the waters off eastern Long Island, New York, U.S.A., 1981–1987. *Marine Mammal Science*, Vol 11, No 2, pp 200–208.

Koster, D., L. Sayigh, K. Urian, and A. Read, 2000. Evidence for year-round residency and extended home ranges by botttlenose dolphins in North Carolina. Page 3 in *Eighth Annual Atlantic Coastal Dolphin Conference*. 24–26 March 2000. Wilmington, North Carolina.

Kovacs, K. M., 2002. Hooded seal *Cystophora cristata*. in *Encyclopedia of Marine Mammals*, Perrin, W.F., B. Würsig, and J.G.M. Thewissen, eds. Academic Press: San Diego, California. pp 580-582.

Kovacs, K. M., and D. M. Lavigne, 1986. *Cystophora cristata*. *Mammalian Species*, Vol 258, pp 1–9.

Krafft, B. A., C. Lydersen, I. Gjertz, and K. M. Kovacs, 2002. Diving behaviour of sub-adult harbour seals (*Phoca vitulina*) at Prins Karls Forland, Svalbard. *Polar Biology*, Vol 25, pp 230–234.

Krahn, M. M., M. J. Ford, W. F. Perrin, P. R. Wade, R. P. Angliss, M. B. Hanson, B. L. Taylor, G. M. Ylitalo, M. E. Dahlheim, J. E. Stein, and R. S. Waples, 2004. 2004 status review of southern resident killer whales (*Orcinus orca*) under the Endangered Species Act. NOAA Technical Memorandum NMFS-NWFSC-62:1–73.

Kraus, S., and G. Early, 1995. Population trends in southern New England as reflected in survey and stranding data, in *Pinniped populations in the Gulf of Maine: Status, issues and management*, M. L. Mooney-Sues and G. S. Stone, eds. New England Aquarium Aquatic Forum Series Report 95-1.New England Aquarium: Boston, Massachusetts.

Kraus, S. D., J. R. Gilbert, and J. H. Prescott, 1983. A comparison of aerial, shipboard, and landbased survey methodology for the harbor porpoise (*Phocoena phocoena*). *Fishery Bulletin*, Vol 81, pp 910–913.

Kraus, S. D., K. E. Moore, C. A. Price, M. J. Crone, W. A. Watkins, H. E. Winn, and J. H. Prescott, 1986. The use of photographs to identify individual North Atlantic right whales (*Eubalaena glacialis*). *Reports of the International Whaling Commission*, Special Issue, Vol 10, pp 145–151.

Kraus, S. D., M. W. Brown, H. Caswell, C. W. Clark, M. Fujiwara, P. K. Hamilton, R. D. Kenney, A. R. Knowlton, S. Landry, C. A. Mayo, W. A. McLellan, M. J. Moore, D. P. Nowacek, D. A. Pabst, A. J. Read, and R. M. Rolland, 2005. North Atlantic right whales in crisis. *Science*, Vol 309, pp 561–562.

Kraus, S. D., R. D. Kenney, A. R. Knowlton, and J. N. Ciano, 1993. Endangered right whales of the southwestern North Atlantic. OCS Study MMS 93-0024. Herndon, Virginia: Minerals Management Service.

Kraus, S. D., R. M. Pace III, and T. R. Frasier. 2007. High investment, low return: The strange case of reproduction in *Eubalaena glacialis*, in *The Urban Whale: North Atlantic Right Whales at the Crossroads*, S. D. Kraus and R. M. Rolland, eds. Harvard University Press: Cambridge, Massachusetts. pp 172–199.

Kruse, S., D. K. Caldwell, and M. C. Caldwell, 1999. Risso's dolphin *Grampus griseus* (G. Cuvier, 1812), in Ridgway, *Handbook of Marine Mammals. Vol 6: The Second Book of Dolphins and the Porpoises*, S.H. and R. Harrison, eds. San Diego, California: Academic Press. pp 183–212.

Kryter K. D., W. D. Ward, J. D. Miller, and D. H. Eldredge, 1966. Hazardous exposure to intermittent and steady-state noise. *Journal of the Acoustical Society of America*, Vol 39, pp 451–464.

Kszos, L. A., J. J. Beauchamp, and A. J. Stewart, 2003. Toxicity of lithium to three freshwater organisms and the antagonistic effect of sodium. *Ecotoxicology*, Vol 12, No 5.

Kvadsheim, P. H., and E. M. Sevaldsen, 2005. The potential impact of 1-8 kHz active sonar on stocks of juvenile fish during sonar exercises. FFI/Report-2005/01027.

Laake, J. L., J. Calambokidis, S. D. Osmek, and D. J. Rugh. 1997. Probability of detecting harbor porpoise from aerial surveys: Estimating g(0). *Journal of Wildlife Management*, Vol 61, No 1, pp 63–75.

Lacroix, D., R. B. Lanctot, J. R. Reed, and T. L. McDonald, 2003. Effect of underwater seismic surveys on molting male long-tailed ducks in the Beaufort Sea, Alaska. *Canadian Journal of Zoology*, Vol 81, pp 1862–1875.

Ladich, F., and A. H. Bass, 2003. Underwater sound generation and acoustic reception in fishes with some notes on frogs, in *Sensory Processing in Aquatic Environments,* S. P. Collin and N. J. Marshall, eds. pp 173–193.

Ladich, F., and A. N. Popper, 2004. Parallel evolution in fish hearing organs, in *Evolution of the Vertebrate Auditory System*, G. Manley, A. N. Popper and R. R. Fay, eds. Springer: New York. pp 95–127.

Ladich, F., and L. E. Wysocki, 2003. How does Weberian ossicle extirpation affect hearing sensitivity in otophysine fishes? *Hearing Research*, Vol 182, pp 119–129.

Laerm, J., F. Wenzel, J.E. Craddock, D. Weinand, J. McGurk, M.J. Harris, G.A. Early, J.G. Mead, C.W. Potter, and N.B. Barros, 1997. New prey species for northwestern Atlantic humpback whales. *Marine Mammal Science*, Vol 13, No 4, pp 705–711.

Lafortuna, C. L., M. Jahoda, A. Azzellino, F. Saibene, and A. Colombini, 2003. Locomotor behaviours and respiratory pattern of the Mediterranean fin whale (*Balaenoptera physalus*). *European Journal of Applied Physiology*, Vol 90, pp 387–395.

Lagerquist, B. A., K. M. Stafford, and B. R. Mate, 2000. Dive characteristics of satellite-monitored blue whales (*Balaenoptera musculus*) off the central California coast. *Marine Mammal Science*, Vol 16, No 2, pp 375–391.

Lahanas, P. N., K. A. Bjorndal, A. B. Bolten, S. E. Encalada, M. M. Miyamoto, R. A. Valverde, and B. W. Bowen, 1998. Genetic composition of a green turtle (*Chelonia mydas*) feeding ground population: Evidence for multiple origins. *Marine Biology*, Vol 130, pp 345–352.

Laist, D. W., 2002. Personal communication via e-mail between Mr. David W. Laist, Marine Mammal Commission and Ms. Dagmar Fertl, Geo-Marine, Inc., Plano, Texas, on 21 May 2002.

Laist, D. W. and J.E. Reynolds III, 2005. Influence of power plants and other warm-water refuges on Florida manatees. *Marine Mammal Science*, Vol 21, No 4, pp 739–764.

Laist, D. W., A. R. Knowlton, J. G. Mead, A. S. Collet, and M. Podesta, 2001. Collisions between ships and whales. *Marine Mammal Science*, Vol 17, No 1, pp 35–75.

Lammers, M. O., W. W. L. Au, and D. L. Herzing, 2003. The broadband social acoustic signaling behavior of spinner and spotted dolphins. *Journal of the Acoustical Society of America*, Vol 114, No 3, pp 1629–1639.

Landry, A. M., Jr., and D. Costa, 1999. Status of sea turtle stocks in the Gulf of Mexico with emphasis on the Kemp's ridley, in *Gulf of Mexico Large Marine EcosystemBlackwell Science*, H. Kumpf, K. Steidinger, and K. Sherman, eds. Malden, MA. pp 248–268.

Laplanche, C., O. Adam, M. Lopatka, and J.-F. Motsch, 2005. Male sperm whale acoustic behavior observed from multipaths at a single hydrophone. *Journal of the Acoustical Society of America*, Vol 118, No 4, pp 2677–2687.

Larsen, A. H., J. Sigurjónsson, N. Øien, G. Vikingsson, and P. Palsbøll, 1996. Populations genetic analysis of nuclear and mitochondrial loci and skin biopsies collected from central and northeastern North Atlantic humpback whales (*Megaptera novaeangliae*): Population identity and migratory destinations. *Biological Sciences*, Vol 263, pp 1611–1618.

Laurinolli, M. H., A. E. Hay, F. Desharnais, and C. T. Taggart, 2003. Localization of North Atlantic right whale sounds in the Bay of Fundy using a sonobuoy array. *Marine Mammal Science*, Vol 19, No 4, pp 708–723.

Lavigne, D. M., 2002. Harp seal *Pagophilus groenlandicus*, in *Encyclopedia of Marine Mammals*, W.F. Perrin, B. Würsig, and J.G.M. Thewissen, eds. Academic Press: San Diego. pp 560–562.

Lazell, J. D., 1980. New England waters: Critical habitat for marine turtles. *Copeia*, Vol 1980, pp 290–295.

Leaper, R. and D. Gillespie, eds., 2006. *Report of the Second Workshop on Right Whale Acoustics: Practical Applications in Conservation*. 4 November 2005. New Bedford Whaling Museum, Massachusetts.

Leary, T. R. 1957. A schooling of leatherback turtles, Dermochelys coriacea coriacea, on the Texas coast. *Copeia*, Vol 1957, No 3, p 232.

Leatherwood, S., and R. R. Reeves, 1983. The Sierra Club handbook of whales and dolphins. San Francisco, California: Sierra Club Books.

Leatherwood, S., and R. Reeves, 1982. Pelagic Sightings of Risso's Dolphin, *Grampus griseus,* in the Gulf of Mexico and Atlantic Ocean Adjacent to Florida. *Journal of Mammalogy*, Vol 63.

Leatherwood, S., D.K. Caldwell, and H.E. Winn, 1976. *Whales, dolphins, and porpoises of the western North Atlantic: A guide to their identification*. NOAA Technical Report NMFS CIRC-396:1–176.

Leatherwood, S., T.A. Jefferson, J.C. Norris, W.E. Stevens, L.J. Hansen, and K.D. Mullin, 1993. Occurrence and sounds of Fraser's dolphins (*Lagenodelphis hosei*) in the Gulf of Mexico. *Texas Journal of Science*, Vol 45, No 4, pp 349–354.

LeBuff, C.R., Jr., 1990. The loggerhead turtle in the eastern Gulf of Mexico. Sanibel, Florida: Caretta Research, Inc.

Lee, D. S. and W. M. Palmer, 1981. Records of Leatherback Turtles, *Dermochelys coriacea* (Linnaeus) and other Marine Turtles in North Carolina Waters. *Brimleyana*, Vol 5, pp 95–106.

Lee, D. S., and M. C. Socci, 1989. *Potential Effects of Oil Spills on Seabirds and Selected Other Oceanic Vertebrates Off the North Carolina Coast*. North Carolina Biological Survey and the North Carolina State Museum of Natural Sciences. Occasional Papers of the NC Biological Survey. 1989–1. Raleigh, North Carolina. 64 pp.

Lefebvre, L. W., M. Marmontel, J. P. Reid, G. B. Rathbun, and D. P. Domning, 2001. Status and biogeography of the West Indian manatee. *Biogeography of the West Indies: Patterns and Perspectives, 2nd edition*, C. A. Woods and F. E. Sergile, eds. CRC Press: Boca Raton, Florida. pp 425–474.

Lefebvre, L.W., M. Marmontel, J. P. Reid, G. B. Rathbun, and D. P. Domning, 2001. Distribution, status, and biogeography of the West Indian manatee, in *Biogeography of the West Indies: Patterns and Perspectives*, *2nd edition*, C.A. Woods and F.E. Sergile, eds. Boca Raton, Florida: CRC Press. pp 425–474.

Lenhardt, M. L., 2002. Sea turtle auditory behavior. *Journal of the Acoustical Society of America*, Vol 112, No 5, pp 2314–2319.

Lenhardt, M.L., 1994. Seismic and Very Low frequency sound induced behaviors in captive loggerhead marine turtles (*Caretta caretta*), in *Proceedings, Fourteenth Annual Symposium on Sea Turtle Biology and Conservation,* NOAA Technical Memorandum NMFS-SEFSC-351, Marine Fisheries Service, Southeast Fisheries Science Center, Miami, Florida, pp 238–241, 32.

Lenhardt, M. L., S. Bellmund, R. A. Byles, S. W. Harkins, and J.A. Musick, 1983. Marine turtle reception of bone conducted sound. *Journal of Auditory Research*, Vol 23, pp 119–125.

Lerman, M., 1986. *Marine Biology: Environment, Diversity, and Ecology*. Benjamin/Cummings Publishing Co. Menlo Park, CA. pp 534.

Lesage, V., and M.C.S. Kingsley, 1998. Updated status of the St. Lawrence River population of the beluga, *Delphinapterus leucas*. *Canadian Field-Naturalist*, Vol 112, pp 98–114.

Lesage, V., and M.O. Hammill, 2001. The status of the grey seal, *Halichoerus grypus*, in the Northwest Atlantic. *Canadian Field-Naturalist*, Vol 115, No 4, pp 653–662.

Lewis, T., D. Gillespie, C. Lacey, J. Matthews, M. Danbolt, R. Leaper, R. McLanaghan, and A. Moscrop, 2007. Sperm whale abundance estimates from acoustic surveys of the Ionian Sea and Straits of Sicily in 2003. *Journal of the Marine Biological Association of the United Kingdom*, Vol 87, pp 353–357.

Lien, J., D. Nelson, and D. J. Hai, 2001. Status of the white-beaked dolphin, *Lagenorhynchus albirostris*, in Canada. *Canadian Field-Naturalist*, Vol 115, pp 118–126.

Liu, Ta-Kang, Hwung, Hwung-Hweng, Yu, Jin-Li, and Kao, Ruey-Chy, 2007. Managing deep ocean water development in Taiwan: Experiences and future challenges. Ocean and Coastal Management, doi:10.1016/j.ocecoaman.2007.04.003.

Lohmann, K. J., and C. M. F. Lohmann, 1996. Orientation and open-sea navigation in sea turtles. *The Journal of Experimental Biology*, Vol 199, pp 73–81.

Lohmann, K. J., 1991. Magnetic orientation by hatchling loggerhead sea turtles (*Caretta caretta*). *The Journal of Experimental Biology*, Vol 155, pp 37–49.

Lohoefener, R., W. Hoggard, K. Mullin, C. Roden, and C. Rogers, 1990. Association of sea turtles with petroleum platforms in the north-central Gulf of Mexico. OCS Study MMS 90-0025. New Orleans: Minerals Management Service.

Long Island Power Authority (LIPA), 2007A. Clean Energy Initiative: Long Island Offshore Wind Park: Frequently Asked Questions – Power Production. Document obtained at http://www.lipower.org/cei/offshore.production.html, on 10 May 2007.

Long Island Power Authority (LIPA), 2007B. Clean Energy Initiative: Long Island Offshore Wind Park: Frequently Asked Questions – Environmental Issues. Document obtained at http://www.lipower.org/cei/offshore.environ.html, on 10 May 2007.

Lovell, J. M., M. M. Findlay, R. M. Moate, and D. A. Pilgrim, 2005. The polarization of inner ear ciliary bundles from a scorpaeniform fish. *Journal of Fish Biology*, Vol 66, No 3, pp 836–846.

Lovell, J. M., M. M. Findlay, R. M. Moate, and H. Y. Yan, 2005. The hearing abilities of the prawn *Palaemon serratus*. *Comparative Biochemistry and Physiology*, Vol 140(a), pp 89–100.

Løvik, A., and J. M. Hovem, 1979. An experimental investigation of swimbladder resonance in fishes. *Journal of the Acoustical Society of America*, Vol 66, pp 850–854.

Lucas, Z. and P.Y. Daoust, 2002. Large increases of harp seals (*Phoca groenlandica*) and hooded seals (*Cystophora cristata*) on Sable Island, Nova Scotia, since 1995. *Polar Biology*, Vol 25, pp 562–568.

Lucas, Z. N. and D. F. McAlpine, 2002. Extralimital occurrences of ringed seals, *Phoca hispida*, on Sable Island, Nova Scotia. *Canadian Field-Naturalist*, Vol 116, No 4, pp 607–610.

Luczkovich, J. J., H. J. Daniel, M. Hutchinson, T. Jenkins, S. E. Johnson, R. C. Pullinger, and M. W. Sprague, 2000. Sounds of sex and death in the sea: bottlenose dolphin whistles suppress mating choruses of silver perch. *Bioacoustics*, Vol 10, pp 323–334.

Lund, P. F., 1985. Hawksbill turtle (*Eretmochelys imbricata*) nesting on the east coast of Florida. *Journal of Herpetology*, Vol 19, pp 164–166.

Lusseau, D., E. Slooten, and R. J. Currey, 2006. Unsustainable dolphin watching activities in Fiordland, New Zealand. *Tourism in Marine Environments,* Vol 3, pp 173 – 178.

Lutcavage, M., and J. A. Musick, 1985. Aspects of the Biology of Sea Turtles in Virginia. *Copeia*, Vol 1985, pp 449–456.

Lydersen, C. and K.M. Kovacs, 1993. Diving behaviour of lactating harp seal, *Phoca groenlandica*, females from the Gulf of St Lawrence, Canada. *Animal Behaviour*, Vol 46, pp 1213–1221.

Lydersen, C. and N.A. Øritsland, 1990. Surface and submerging intervals in minke whale, *Balaenoptera acutorostrata*, diving cycles. *Fauna Norvegica*, Vol 11, Series A, pp 35–37.

Lydersen, C., 1991. Monitoring ringed seal (*Phoca hispida*) activity by means of acoustic telemetry. *Canadian Journal of Zoology*, Vol 69, pp 1178–1182.

Lydersen, C., M. O. Hammill, and K. M. Kovacs, 1994. Activity of lactating ice-breeding grey seals, *Halichoerus grypus*, from the Gulf of St Lawrence, Canada. *Animal Behaviour*, Vol 48, pp 1417–1425.

Lynch, T., and J. Harrington, 2003. *NOPP Regional Ocean Observing Systems Benefits Project: Center for Economic Forecasting and Analysis (CEFA) Economic Impact Analysis of the Gulf of Mexico Region*. Presented to the NOPP Co-PI's Meeting. Washington D.C.

MacLeod, C. D., and A. D'Amico, 2006. A review of beaked whale behaviour and ecology in relation to assessing and mitigating impacts of anthropogenic noise. *Journal of Cetacean Research and Management*, Vol 7, No 3, pp 211–221.

MacLeod, C. D., and D. Claridge, 1999. Habitat use in dense beaked whales, *Mesoplodon densirostris*, in *Abstracts, Thirteenth Biennial Conference on the Biology of Marine Mammals*. 28 November – 3 December 1999. Wailea, Hawaii. p 112.

MacLeod, C. D. and G. Mitchell, 2006. Key areas for beaked whales worldwide. *Journal of Cetacean Research and Management*, Vol 7, No 3, pp 309–322.

MacLeod, C. D., 1999. A review of beaked whale acoustics, with inferences on potential interactions with military activities. *European Research on Cetaceans*, Vol 13, pp 35–38.

MacLeod, C. D., 2000a. Species recognition as a possible function for variations in position and shape of the sexually dimorphic tusks of *Mesoplodon* whales. *Evolution*, Vol 54, No 6, pp 2171–2173.

MacLeod, C. D., 2000b. Review of the distribution of *Mesoplodon* species (Order Cetacea, Family Ziphiidae) in the North Atlantic. *Mammal Review*, Vol 30, No 1, pp 1–8.

MacLeod, C. D., W.F. Perrin, R. Pitman, J. Barlow, L. Ballance, A. D'Amico, T. Gerrodette, G. Joyce, K.D. Mullin, D.L. Palka, and G.T. Waring, 2006. Known and inferred distributions of beaked whale species (Cetacea: Ziphiidae). *Journal of Cetacean Research and Management*, Vol 7, No 3, pp 271–286.

Madsen, P. T., D. A. Carder, W. W. L. Au, P. E. Nachtigall, B. Møhl, and S.H. Ridgway, 2003. Sound production in neonate sperm whales (L). *Journal of the Acoustical Society of America*, Vol 113, pp 2988–2991.

Madsen, P. T., D.A. Carder, K. Bedholm, and S.H. Ridgway, 2005a. Porpoise clicks from a sperm whale nose – convergent evolution of 130 kHz pulses in toothed whale sonars? *Bioacoustics*, Vol 15, pp 195–206.

Madsen, P. T., I. Kerr, and R. Payne, 2004a. Echolocation clicks of two free-ranging, oceanic delphinids with different food preferences: False killer whales *Pseudorca crassidens* and Risso's dolphins *Grampus griseus*. *Journal of Experimental Biology*, Vol 207, pp 1811–1823.

Madsen, P. T., I. Kerr, and R. Payne, 2004b. Source parameter estimates of echolocation clicks from wild pygmy killer whales (*Feresa attenuata*) (L). *Journal of the Acoustical Society of America*, Vol 116, No 4, Part 1, pp 1909–1912.

Madsen, P. T., M. Johnson, N. Aguilar de Soto, W. M. X. Zimmer, and P. Tyack, 2005b. Biosonar performance of foraging beaked whales (*Mesoplodon densirostris*). *Journal of Experimental Biology*, Vol 208, No 2, pp 181–194.

Madsen, P. T., M. Johnson, P. J. Miller, N. Aguilar Soto, J. Lynch, and P. Tyack. 2006. Quantitative measures of air-gun pulses recorded on sperm whales (*Physeter macrocephalus*) using acoustic tags during controlled exposure experiments. *Journal of the Acoustical Society of America,* Vol 120, No 4, pp 2366–2379.

Madsen, P.T. and M. Wahlberg. 2007. Recording and quantification of ultrasonic echolocation clicks from free-ranging toothed whales. *Deep-Sea Research I*, Vol 54, pp 1421–1444.

Magnuson, J. J., J. A. Bjorndal, W. D. DuPaul, G. L. Graham, D. W. Owens, C. H. Peterson, P. C. H. Pritchard, J. I. Richardson, G. E. Saul, and C. W. West, 1990. *Decline of sea turtles: causes and prevention*. National Research Council, National Academy Press, Washington, D.C., USA.

Makowski, C., J. A. Seminoff, and M. Salmon, 2006. Home range and habitat use of juvenile Atlantic green turtles (*Chelonia mydas* L.) on shallow reef habitats in Palm Beach, Florida, USA. *Marine Biology*, Vol 148, pp 1167–1179.

Malme, C.I., P.R. Miles, C.W. Clark, P. Tyack, and J.E. Byrd, 1984. Investigations of the Potential Effects of Underwater Noise from Petroleum Industry Activities on Migrating Gray Whale Behavior/Phase II. BBN Rep. 586. Rep. from Bolt, Beranek, and Newman, Inc. for US Minerals Management Service. Anchorage, Alaska. NTIS PB-86-218377.

Manghi, M., G. Montesi, C. Fossati, G. Pavan, M. Priano, and V. Teloni, 1999. Cuvier's beaked whales in the Ionian Sea: First recordings of their sounds. *European Research on Cetaceans*, Vol 13, pp 39–42.

Manire, C.A. and R.S. Wells, 2005. *Rough-toothed dolphin rehabilitation and post-release monitoring* Mote Marine Laboratory Technical Report Number 1047. Sarasota, Florida: Mote Marine Laboratory.

Mann D. A., D. M. Higgs, W. N. Tavolga, M. J. Souza, and A. N. Popper, 2001. Ultrasound detection by clupeiform fishes. *Journal of the Acoustical Society of America*, Vol 109, pp 3048–3054.

Mann D. A., Z. Lu, and A. N. Popper, 1997. Ultrasound detection by a teleost fish. *Nature*, Vol 389, pp 341.

Mann, D. A., A. N. Popper, and B. Wilson, 2005. Pacific herring hearing does not include ultrasound. *Biology Letters*, Vol 22, pp 158–161.

Mann, D. A., and P. S. Lobel, 1997. Propagation of damselfish (*Pomacentridae*) courtship sounds. *Journal of the Acoustical Society of America*, Vol 101, pp 3783–3791.

Mann, D. A., Z. Lu, M. C. Hastings, and A. N. Popper, 1998. Detection of ultrasonic tones and simulated dolphin echolocation clicks by a teleost fish, the American shad (*Alosa sapidissima*). *Journal of the Acoustical Society of America,* Vol 104, No 1, pp 562–568.

Mann, D.A., T.J. O'Shea, and D.P. Nowacek, 2006. Nonlinear dynamics in manatee vocalization. *Marine Mammal Science,* Vol 22, No 3, pp 548–555.

Mansfield, K. L., and J. A. Musick, 2003. *Loggerhead sea turtle diving behavior*. Prepared for the U.S. Army Corps of Engineers, Norfolk, Virginia by the Virginia Institute of Marine Science, Gloucester Point, Virginia.

Mansfield, K. L., and J. A. Musick, 2006. Northwest Atlantic loggerheads: Addressing data gaps in sub-adult abundance estimates. in *Abstracts, 26th Annual Symposium on Sea Turtle Biology and Conservation*. 3-8 March 2006. Athens, Greece. pp 304–305.

Manville, R.H., and P.G. Favour, Jr., 1960. Southern distribution of the Atlantic walrus. *Journal of Mammalogy*, Vol 41, No 4, pp 499–503.

Manzella, S. A., C. Caillouet, Jr., and C. T. Fontaine, 1988. Kemp's ridley ,*Lepidochelys kempii*, sea turtle head start tag recoveries: Distribution, habitat, and method of recovery. *Marine Fisheries Review*, Vol 50, No 3, pp 24–32.

Manzella, S., K. Bjornddal, and C. Lagueux, 1991. Head-started Kemp's ridley recaptured in Caribbean. *Marine Turtle Newsletter*, Vol 54, pp 13–14.

Marcoux, M., H. Whitehead, and L. Rendell, 2006. Coda vocalizations recorded in breeding areas are almost entirely produced by mature female sperm whales *(Physeter macrocephalus)*. *Canadian Journal of Zoology*, Vol 84, pp 609–614.

Marine Mammal Commission (MMC), 2002. *Annual report to Congress 2001*. Bethesda, Maryland: Marine Mammal Commission.

Marine Mammal Commission (MMC), 2003. *Annual report to Congress 2002*. Bethesda, Maryland: Marine Mammal Commission.

Marine Mammal Commission (MMC), 2004. *Annual report to Congress 2003*. Bethesda, Maryland: Marine Mammal Commission.

Marine Mammal Commission (MMC), 2006a. *Annual report to Congress 2005*. Bethesda, Maryland: Marine Mammal Commission.

Marine Mammal Commission (MMC), 2006b. *Advisory Committee Report on Acoustic Impacts on Marine Mammals*. February.

Maritime Administration (MARAD), 2008. Current/Planned Deepwater Ports. Retrieved from http://www.marad.dot.gov/dwp/lng/deepwater_ports/index.asp, on May 16 2008.

Marquez, R., 1989. Status report of the Kemp's ridley turtle, in *Proceedings of the 2nd Western Atlantic Turtle Symposium*, Ogren, L., F. Berry, K. Bjorndal, H. Kumpf, R. Mast, G. Medina, H. Reichart, and R. Witham, eds. NOAA Technical Memorandum NMFS-SEFC-226. pp 159–168.

Marquez, R., 1994. *Synopsis of Biological Data on the Kemp's Ridley Sea Turtle, Lepidochelys kempi (Garman 1880)*. National Oceanic and Atmospheric Administration Technical Memorandum NMFS-SEFSC-343.

Márquez-M., R., P. M. Burchfield, J. Díaz-F., M. Sánchez-P., M. Carrasco-A., C. Jiménez-Q., A. Leo-P., R. Bravo-G., and J. Peña-V, 2005. Status of the Kemp's ridley sea turtle, Lepidochelys kempii. *Chelonian Conservation and Biology*, Vol 4, No 4, pp 761–766.

Marsh H., and D. F. Sinclair, 1989. Correcting for visibility bias in strip transect aerial surveys of aquatic fauna. *Journal of Wildlife Management*, Vol 53, pp 1017–1024.

Marsh, H., and D. F. Sinclair, 1989. An experimental evaluation of dugong and sea turtle aerial survey techniques. *Australian Wildlife Research*, Vol 16, pp 639–650.

Marsh, H., and W. K. Saalfeld, 1989. Aerial surveys of sea turtles in the Northern Great Barrier Reef Marine Park. *Australian Wildlife Research*, Vol 16, pp 239–249.

Marten, K., 2000. Ultrasonic analysis of pygmy sperm whale (Kogia breviceps) and Hubbs' beaked whale (*Mesoplodon carlhubbsi*) clicks. *Aquatic Mammals*, Vol 26, No 1, pp 45–48.

Martin, A. R., and T. G. Smith, 1992. Deep diving in wild, free-ranging beluga whales, *Delphinapterus leucas*. *Canadian Journal of Fisheries and Aquatic Sciences*, Vol 49, pp 462–466.

Martin, A. R., T. G. Smith, and O. P. Cox, 1998. Dive form and function in belugas *Delphinapterus leucas* of the eastern Canadian High Arctic. *Polar Biology*, Vol 20, pp 218–228.

Mate, B., and M. Baumgartner, 2001. Summer feeding season movements and fall migration of North Atlantic right whales from satellite-monitored radio tags, in *Abstracts, Fourteenth Biennial Conference on the Biology of Marine Mammals*. 28 November–3 December 2001. Vancouver, British Columbia. p 137.

Mate, B., 1989. Satellite-monitored radio tracking as a method for studying cetacean movements and behavior. *Reports of the International Whaling Commission*, Vol 39, pp 389–391.

Mate, B. R., B. A. Lagerquist, M. Winsor, J. Geraci, and J.H. Prescott, 2005. Movements and dive habits of a satellite-monitored longfinned pilot whale (*Globicephala melas*) in the northwest Atlantic. *Marine Mammal Science*, Vol 21, No 1, pp 136–144.

Mate, B. R., K. A. Rossbach, S. L. Nieukirk, R. S. Wells, A. B. Irvine, M. D. Scott, and A. J. Read, 1995. Satellite-monitored movements and dive behavior of a bottlenose dolphin (*Tursiops truncatus*) in Tampa Bay, Florida. *Marine Mammal Science*, Vol 11, No 4, pp 452–463.

Mate, B. R., K. M. Stafford, R. Nawojchik, and J. L. Dunn, 1994. Movements and dive behavior of a satellite-monitored Atlantic white-sided dolphin (*Lagenorhynchus acutus*) in the Gulf of Maine. *Marine Mammal Science*, Vol 10, pp 116–121.

Mate, B. R., S.L. Nieukirk, and S. D. Kraus, 1997. Satellite-monitored movements of the northern right whale. *Journal of Wildlife Management*, Vol 61, No 4, pp 1393–1405.

Matthews, J. N., S. Brown, D. Gillespie, M. Johnson, R. McLanaghan, A. Moscrop, D. Nowacek, R. Leaper, T. Lewis, and P. Tyack, 2001. Vocalisation rates of the North Atlantic right whale (*Eubalaena glacialis*). *Journal of Cetacean Research and Management*, Vol 3, No 3, pp 271–282.

Mattila, D. K., L. N. Guinee, and C. A. Mayo, 1987. Humpback whale songs on a North Atlantic feeding ground. *Journal of Mammalogy*, Vol 68, No 4, pp, 880–883.

Mauch, M., 2004. Local killer whale sighting goes down in record book. Retreived from http://www.kristv.com/global/story.asp?S=1607481&nav=BsmgKHnu., on 28 August 2006

Mazarella, K., 2001. Personal communication via email between Ms. Kristen Mazarella, Network for Endangered Sea Turtles, Kitty Hawk, NC and Ms. Yolanda Leon, University of Rhode Island, Kingston, RI, on 11 April 2001.

Mazzarella, K., 2001. Personal communication via email between Ms. Kristen Mazzarella (Network for Endangered Sea Turtles, Kitty Hawk, North Carolina) and Ms. Yolanda Leon (University of Rhode Island, Kingston, Rhode Island) on 11 April 2001.

Mazzuca, L., S. Atkinson, B. Keating, and E. Nitta, 1999. Cetacean Mass Strandings in the Hawaiian Archipelago, 1957–1998. *Aquatic Mammals*, Vol 25, pp 105–114.

McAlpine, D. F., and R. H. Walker, 1990. Extralimital records of the harp seal, *Phoca groenlandica*, from the western North Atlantic: A review. *Marine Mammal Science*, Vol 6, No 3, pp 248–252.

McAlpine, D. F., and R. J. Walker, 1999. Additional extralimital records of the harp seal, *Phoca groenlandica*, from the Bay of Fundy, New Brunswick. *Canadian Field-Naturalist*, Vol 113, pp 290–292.

McAlpine, D. F., P. T. Stevick, and L. D. Murison, 1999a. Increase in extralimital occurrences of ice-breeding seals in the northern Gulf of Maine region: More seals or fewer fish? *Marine Mammal Science*, Vol 15, No 3, pp 906–911.

McAlpine, D. F., P. T. Stevick, L. D. Murison, and S. D. Turnbull, 1999b. Extralimital records of hooded seals (*Cystophora cristata*) from the Bay of Fundy and northern Gulf of Maine. *Northeastern Naturalist*, Vol 6, pp 225–230.

McCartney, B. S., and A. R. Stubbs, 1971. Measurements of the acoustic target strengths of fish in dorsal aspect, including swimbladder resonance. *Journal of Sound and Vibration*, Vol 15, No 3, pp 397–404.

McCauley, R. D., and D. H. Cato, 2000. Patterns of fish calling in a nearshore environment in the Great Barrier Reef. *Philosophical Transaction of the Royal Society of London*, Vol 355, pp 1289–1293.

McCauley, R. D., J. Fewtrell, A. J. Duncan, C. Jenner, M.-N. Jenner, J. D. Penrose, R. I. T. Prince, A. Adhitya, J. Murdoch, and K. McCabe, 2000. *Marine seismic surveys: analysis and propagation of air-gun signals; and effects of air-gun exposure on humpback whales, sea turtles, fishes and squid*. CMST 163, Report R99-15, prepared for the Australian Petroleum Production Exploration Association from the Centre for Marine Science and Technology, Curtin University, Perth, Western Australia.

McCauley, R. D., J. Fewtrell, A.J. Duncan, C. Jenner, M. N. Jenner, J.D. Penrose, R. I. T. Prince, A. Adhitya, J. Murdock, and K. McCabe, 2000b. Marine seismic surveys – a study of environmental implications. *Australian Petroleum Production and Exploration Association Journal*, Vol 2000, pp 692–708.

McCauley, R. D., J. Fewtrell, and A. N. Popper, 2003. High intensity anthropogenic sound damages fish ears. *Journal of the Acoustical Society of America*, Vol 113, No 1, pp 638–642.

McCauley, R. D., D. H. Cato, and A. F. Jeffery, 1996. *A study of the impacts of vessel noise on humpback whales in Hervey Bay, Australia*. Report prepared by the Department of marine Biology of the James Cook University for the Queenland Department of Environment and Heritage, Maryborough Office; Maryborough, Queensland, Australia.

McCune, S., 2004. Contact page for Gulf of Mexico killer whale research. Retrieved from http://www.fishntexas.com/assoc_killer_whales.htm, on 20 October 2006

McDonald, D. L., and P. H. Dutton, 1996. Use of PIT tags and photoidentification to revise remigration estimates of leatherback turtles (*Dermochelys coriacea*) nesting in St. Croix, US Virgin Islands, 1979–1995. *Chelonian Conservation Biology*, Vol 1996, No 2, pp 148–152.

McDonald, M. A., and C. G. Fox, 1999. Passive acoustic methods applied to fin whale population density estimation. *Journal of the Acoustical Society of America*, Vol 105, No 5, pp 2643–2651.

McDonald, M. A., J. Calambokidis, A. M. Teranishi, and J. A. Hildebrand, 2001. The acoustic calls of blue whales off California with gender data. *Journal of the Acoustical Society of America*, Vol 109, No 4, pp 1728–1735.

McDonald, M. A., J. A. Hildebrand, S. M. Wiggins, D. Thiele, D. Glasgow, and S. E. Moore, 2005. Sei whale sounds recorded in the Antarctic. *Journal of the Acoustical Society of America*, Vol 118, No 6, pp 3941–3945.

McEwen, B. S., and J. C. Wingfield, 2003. The concept of allostasis in biology and biomedicine. *Hormones and Behavior*, Vol 43, pp 2–15.

McNicholl, M. K., P. E. Lowther, and J. A. Hall, 2001. Forster's Tern (*Sterna forsteri*), in *The Birds of North America*, A. Poole and F. Gill, eds. No. 595 The Birds of North America, Inc.: Philadelphia, PA.

Mead, J. G., 1989. Beaked Whales of the Genus-Mesoplodon, in *Handbook of Marine Mammals Vol 4: River Dolphins and the Larger Toothed Whales,* S. H. Ridgway and R. Harrison, eds. Academic Press: London, England. pp 349–430.

Mead, J. G. and C. W. Potter, 1990. Natural history of bottlenose dolphins along the central Atlantic coast of the United States, in *The Bottlenose Dolphin*, S. Leatherwood and R. R. Reeves, eds. Academic Press: San Diego, California. pp 165–195.

Mead, J. G. and C. W. Potter, 1995. Recognizing two populations of the bottlenose dolphin (*Tursiops truncatus*) off the Atlantic Coast of North America: Morphologic and ecologic considerations. *IBI Reports*, Vol 5, pp 1–44.

Mead, J. G., 1977. Records of sei and Bryde's whales from the Atlantic Coast of the United States, the Gulf of Mexico, and the Caribbean. *Reports of the International Whaling Commission*, Special Issue, Vol 1, pp 113–116.

Mead, J. G., 1989a. Beaked whales of the genus-*Mesoplodon*, in *Handbook of Marine Mammals, Vol 4: River Dolphins and the Larger Toothed Whales*, S. H. Ridgway and R. Harrison, eds. Academic Press: London, United Kingdom. pp 349–430.

Mead, J. G., 1989b. Bottlenose whales *Hyperoodon ampullatus* (Forster, 1770) and *Hyperoodon planifrons* (Flower, 1882), in *Handbook of Marine Mammals. Volume 4: River Dolphins and the Larger Toothed Whales*, S.H. Ridgway and R. Harrison, eds. London, United Kingdom: Academic Press. pp 321–348.

Measures, L., B. Roberge, and R. Sears, 2004. Stranding of a pygmy sperm whale, *Kogia breviceps*, in the northern Gulf of St. Lawrence, Canada. *Canadian Field-Naturalist*, Vol 118, No 4, pp 495–498.

Mellgren, R. L., M. A. Mann, M. E. Bushong, S. R. Harkins, and V. K. Krumke. 1994. Habitat selection in three species of captive sea turtle hatchlings. in *Proceedings of the Fourteenth Annual Symposium on Sea Turtle Biology and Conservation*, K. A. Bjorndal, A. B. Bolten, D. A. Johnson, and P. J. Eliazar, eds. NOAA Technical Memorandum NMFS-SEFSC-351. pp 259–261.

Mellinger, D. K., and C. W. Clark, 2003. Blue whale (*Balaenoptera musculus*) sounds from the North Atlantic. *Journal of the Acoustical Society of America*, Vol 114, pp 1108–1119.

Mellinger, D. K., C. D. Carson, and C. W. Clark, 2000. Characteristics of minke whale (*Balaenoptera acutorostrata*) pulse trains recorded near Puerto Rico. *Marine Mammal Science*, Vol 16, No 4, pp 739–756.

Mercer, M. C., 1967. Records of the Atlantic walrus, *Odobenus rosmarus rosmarus*, from Newfoundland. *Journal of the Fisheries Research Board of Canada*, Vol 24, pp 2631–2635.

Meylan A. B., 1992. Hawksbill Turtle *Eretmochelys imbricate*, in *Rare and Endangered Biota of Florida*, P. Moler ed.. University Press of Florida: Gainesville, Florida. pp 95–99.

Meylan A. B., and A. Redlow, 2006. *Eretmochelys imbricata* – hawksbill turtle, in *Biology and Conservation of Florida Turtles,* P. A. Meylan ed. *Chelonian Research Monographs 3*. pp 105–127.

Meylan A. B., and M. Donnelly, 1999. Status justification for listing the hawksbill turtle (*Eretmochelys imbricata*) as critically endangered on the 1996 IUCN Red List of Threatened Animals. *Chelonian Conservation and Biology*, Vol 3, No 2, pp 200–224.

Meylan A. B., P. Castaneda, C. Coogan, T. Lozon, and J. Fletemeyer, 1990. First recorded nesting by Kemp's ridley in Florida, USA. *Marine Turtle Newsletter*,Vol 4, pp 8–9.

Meylan, A. B., 1999. Status of the hawksbill turtles (*Eretmochelys imbricata*) in the Caribbean Region. *Chelonian Conservation and Biology*, Vol 3, No 2, pp 177–184.

Meylan, A. B., B. E. Witherington, B. Brost, R. Rivero, and P. S. Kubilis, 2006. Sea turtle nesting in Florida, USA: assessments of abundance and trends for regionally significant populations of *Caretta*, *Chelonia*, and *Dermochelys*, in *Book of Abstracts*, *Twenty-sixth Annual Symposium on Sea Turtle Biology and Conservation*, M. Frick, A. Panagopoulou, A. F. Rees, and K. Williams (compilers). International Sea Turtle Society, Athens, Greece. pp 306–307.

Meylan, A., B. Schroeder, and A. Mosier, 1995. *Sea turtle nesting activity in the state of Florida, 1979-1992*. Florida Marine Research Publications Number 52. St. Petersburg: Florida Department of Environmental Protection.

Meylan, A. B., 1995. Sea turtle migration—evidence from tag returns, in *Biology and Conservation of Sea Turtles*, K.A. Bjorndal, ed. Rev. ed. Smithsonian Institution Press: Washington, D.C. pp 91–100.

Mignucci-Giannoni, A. A., and D. K. Odell, 2001. Tropical and subtropical records of hooded seals (*Cystophora cristata*) dispel the myth of extant Caribbean monk seals (*Monachus tropicalis*). *Bulletin of Marine Science*, Vol 68, No 1, pp 47–58.

Mignucci-Giannoni, A. A., and P. Haddow, 2002. Wandering hooded seals. *Science*, Vol 295, pp 627–628.

Mignucci-Giannoni, A. A., 1989. Zoogeography of marine mammals in Puerto Rico and the Virgin Islands. Master's thesis, University of Rhode Island.

Mignucci-Giannoni, A. A., 1996. Marine mammal strandings in Puerto Rico and the United States and British Virgin Islands. Ph.D. dissertation., University of Puerto Rico.

Mignucci-Giannoni, A. A., 1998. Zoogeography of cetaceans off Puerto Rico and the Virgin Islands. Caribbean *Journal of Science*, Vol 34, No 3, pp 173–190.

Mignucci-Giannoni, A. A., S. L. Swartz, A. Martínez, C. M. Burks, and W. A. Watkins, 2003. First records of the pantropical spotted dolphin (*Stenella attenuata*) for the Puerto Rican Bank, with a review of the species in the Caribbean. *Caribbean Journal of Science*, Vol 39, No 3, pp 381–392.

Miksis, J. L., Connor, R. C., Grund, M. D., Nowacek, D. P., Solow, A. R., and Tyack, P. L. (2001). Cardiac responses to acoustic playback experiments in the captive bottlenose dolphin (*Tursiops truncatus*), *Journal of Comparative Psychology*, Vol 115, pp 227–232.

Miksis-Olds, J. L., Donaghay, P. L., Miller, J. H., Tyack, P. L., and Nystuen, J. A., 2007. Noise level correlates with manatee use of foraging habitats, *Journal of the Acoustical Society of America*, Vol 121, pp 3011–3020.

Miller P. J., N. Biassoni, A. Samuels, and P. L. Tyack, 2000. Whale songs lengthen in response to sonar. *Nature*, Vol 405, pp 903.

Miller, J. D., 1974. Effects of noise on people. *Journal of the Acoustical Society of America*, Vol 56, pp 729–764.

Miller, J. D., C. S. Watson, and W. P. Covell, 1963. Deafening effects of noise on the cat. *Acta Oto-Laryngologica* Supplement, Vol 176, pp 1–91.

Miller, P. J. O., 2006. Diversity in sound pressure levels and estimated active space of resident killer whale vocalizations. *Journal of Comparative Physiology A*, Vol 192, pp 449–459.

Miller, P. J. O., M.P. Johnson, and P.L. Tyack, 2004. Sperm whale behaviour indicates the use of echolocation click buzzes "creaks" in prey capture. *Proceedings of the Royal Society B: Biological Sciences*, Vol 271, pp 2239–2247.

Mills, J. H., R. M. Gilbert, and W. Y. Adkins, 1979. Temporary threshold shifts in humans exposed to octave bands of noise for 16 to 24 hours. *Journal of the Acoustical Society of America*, Vol 65, pp 1238–1248.

Minerals Management Service (MMS), 2001. *Gulf of Mexico OCS Oil And Gas Lease Sale 181: Eastern Planning Area. Volume 1 & 2. Final Environmental Impact Statement*. OCS EIS/EA MMS 2002-051. New Orleans, Louisiana: Minerals Management Service.

Minerals Management Service (MMS), 2003a. *Programmatic Environmental Assessment for Grid 3 Evaluation of Kerr Mcgee Oil and Gas Corporation's Development Operations Coordination Document, N-7625 Gunnison Project Garden Banks Blocks 667, 668, and 669*. MMS 2003-021.

Minerals Management Service (MMS), 2003b. *Gulf of Mexico OCS Oil and Gas Lease Sales 189 and 197. Eastern Planning Area. Final Environmental Impact Statement*. U.S. Department of the Interior, Minerals Management Service, Gulf of Mexico OCS Region. MMS 2003-020.

Minerals Management Service (MMS), 2003c. Personal communication (email) between Rick Combs, SAIC, and Joe Perryman, Minerals Management Service. 16 April 2003.

Minerals Management Service (MMS), 2006a. *Environmental Assessment and Finding of No New Significant Impact for Proposed Outer Continental Shelf Lease Sale 200, Western Gulf of Mexico*. March 2006.

Minerals Management Service (MMS), 2006b. *Assessment of Undiscovered Technically Recoverable Oil and Gas Resources of the Nation's Outer Continental Shelf, 2006*. MMS Fact Sheet RED-2006-01b. February 2006.

Minerals Management Service (MMS), 2006c. *Planning Area Resources Addendum to Assessment of Undiscovered Technically Recoverable Oil and Gas Resources of the Nation's Outer Continental Shelf, 2006*. MMS Fact Sheet RED-2006-02. July 2006.

Minerals Management Service (MMS), 2006d. *Minerals Management Service to Start Environmental Review*. Press Release Issued 21 December 2006.

Minerals Management Service (MMS), 2007a. Atlantic OCS Fast Facts and Figures-Offshore Natural Gas and Oil Operations. Retrieved from http://www.gomr.mms.gov/homepg/offshore/atlocs/atocsfax.html, on 6 March 2007.

Minerals Management Service (MMS), 2007b. Atlantic OCS Lease Status Information. Retrieved from http://www.gomr.mms.gov/homepg/offshore/atlocs/atlleas.html , on 6 March 2007.

Minerals Management Service (MMS), 2007c. Federal Offshore Lands. Document obtained at http:// www.mms.gov/aboutmms/FedOffshoreLands.htm, on 10 May 2007.

Minerals Management Service (MMS), 2007d. Alternate Energy: Projects-Cape Wind Energy Project Fact Sheet. Document obtained at http://www.mms.gov/offshore/RenewableEnergy/CapeWind.htm, on 10 May 2007.

Minerals Management Service (MMS), 2007e. OCS Alternative Energy and Alternate Use Programmatic Environmental Impact Statement (EIS) Information Center: Offshore Wind Energy Fact Sheet. Document obtained at http://ocsenergy.anl.gov/guide/wind/index.cfm, on 10 May 2007.

Minerals Management Service (MMS), 2007f. Alternate Energy: Projects-Long Island Offshore Wind Park Project Fact Sheet. Document obtained at http://www.mms.gov/offshore/RenewableEnergy/LIOWP.htm, on 10 May 2007.

Minerals Management Service (MMS). 2007g. *Final EIS for the Outer Continental Shelf Oil and Gas Leasing Program 2007-2012*. April.

Minerals Management Service (MMS), 2007h. *Proposed Final Program Outer Continental Shelf Oil and Gas Leasing Program 2007–2012*. U.S. Department of the Interior, Minerals Management Service. April. Document obtained at http://www.mms.gov/5%2Dyear/PDFs/MMSProposedFinalProgram2007-2012.pdf on 13 December 2007.

Minerals Management Service (MMS), 2007i. *Final Environmental Impact Statement for Gulf of Mexico OCS Oil and Gas Lease Sales: 2007-2012; Western Planning Area Sales 204, 207, 210, 215, and 218; Central Planning Area Sales 205, 206, 208, 213, 216, and 222*. April 2007.

Minerals Management Service (MMS), 2007j. *Oil, Gas, and Sulphur Operations in the Outer Continental Shelf (OCS)-Plans and Information-Protection of Marine Mammals and Threatened and Endangered Species*. Minerals Management Service (MMS), Department of the Interior. 13 April 2007. *Federal Register*, Volume 72, Number 71. Document retrieved from http://www.gomr.mms.gov/homepg/whatsnew/newsreal/2007/070416afr.pdf, on 21 June 2007.

Minerals Management Service (MMS), 2007k. *Final Supplemental Environmental Impact Statement for Gulf of Mexico OCS Oil and Gas Lease Sale 224, Eastern Planning Area*. October.

Minerals Management Service (MMS), 2007l. *Environmental Assessment for the Proposed Gulf of Mexico OCS Oil and Gas Lease Sale 206, Central Planning Area*. October 2007.

Minerals Management Service (MMS), 2007m. *Programmatic Environmental Impact Statement for Alternative Energy Development and Production and Alternate Use of Facilities on the Outer Continental Shelf.* October 2007.

Minerals Management Service (MMS), 2008a. *Draft Supplemental Environmental Impact Statement for Gulf of Mexico OCS Oil and Gas Lease Sales: 2009-2012; Central Planning Area Sales 208, 213, 216, and 222; Western Planning Area Sales 210, 215,c and 218*. April 2008.

Minerals Management Service (MMS), 2008b. Alternative Energy and Alternate uses of Existing Facilities on the Outer Continental Shelf; Proposed Rule. *Federal Register*, Vol. 73, No. 132, pp 39376–39384. July 9, 2008.

Minerals Management Service (MMS), 2008c. Atlantic OCS Lease Status Information. Retrieved from http://www.gomr.mms.gov/homepg/offshore/atlocs/atlleas.html on November 9, 2008.

Misund, O.A. 1993. Avoidance behavior of herring (*Clupea harengus*) and mackerel (*Scomber scombus*) in purse seine capture situations. *Fisheries Research*, Vol 16, pp 179–194.

Mitchell, E., and D. G. Chapman, 1977. Preliminary assessment of stocks of northwest Atlantic sei whales (*Balaenoptera borealis*). *Reports of the International Whaling Commission*, Special Issue 1, pp 117–120.

Mitchell, E. D., Jr., 1991. Winter records of the minke whale (*Balaenoptera acutorostrata acutorostrata* Lacépède 1804) in the southern North Atlantic. *Reports of the International Whaling Commission*, Vol 41, pp 455–457.

Mitchell, E., V. M. Kozicki, and R. R. Reeves, 1986. Sightings of right whales, *Eubalaena glacialis*, on the Scotian Shelf, 1966–1972. *Reports of the International Whaling Commission*, Special Issue 10, pp 83–107.

Mitchell, G. H., R. D. Kenney, A. M. Farak, and R. J. Campbell, 2002. *Evaluation of occurrence of endangered and threatened marine species in Naval ship trial areas and transit lanes in the Gulf of Maine and offshore of Georges Bank*. NUWC-NPT Technical Memorandum 02-121. Newport, Rhode Island: Naval Undersea Warfare Center Division.

Miyazaki, N., and W. F. Perrin, 1994. Rough-toothed dolphin *Steno bredanensis* (Lesson, 1828), in *Handbook of Marine Mammals, Vol 5: The First Book of Dolphins*, S.H. Ridgway and R. Harrison, eds. Academic Press: San Diego, California. pp 1–21.

Mobley, J. R., Jr., 2004. *Results of marine mammal surveys on U.S. Navy underwater ranges in Hawaii and Bahamas*. Award number N000140210841. Prepared for Office of Naval Research (ONR) Marine Mammal Program by Marine Mammal Research Consultants.

Mobley, J. R., Jr., S. S. Spitz, and R. Grotefendt. 2001. *Abundance of humpback whales in Hawaiian waters: Results of 1993-2000 aerial surveys*. Prepared for the Hawaiian Islands Humpback Whale National Marine Sanctuary and the Hawai'i Department of Land and Natural Resources.

Moein Bartol, S. and D. R. Ketten, 2006. Turtle and Tuna Hearing. U.S. Department of Commerce, NOAA Technical Memorandum, NOAA-TM-NMFS-PIFSC-7, pp 98–105.

Moein Bartol, S., J. A. Musick, and M. L. Lenhardt, 1999. Auditory evoked potentials of the loggerhead sea turtle (*Caretta caretta*). *Copeia*, Vol 1999, No 3, pp 836–840.

Møhl, B., M. Wahlberg, P. T. Madsen, A. Heerfordt, and A. Lund, 2003. The monopulsed nature of sperm whale clicks. *Journal of the Acoustical Society of America*, Vol 114, pp 1143–1154.

Mohn, R., and W. D. Bowen, 1996. Grey seal predation on the eastern Scotian Shelf: Modelling the impact on Atlantic Cod. *Canadian Journal of Fisheries and Aquatic Sciences*, Vol 53, pp 2722–2738.

Mooney, T. A., 2006. Personal communication via email between Dr. Aran Mooney, University of Hawaii, Marine Mammal Research Program, Kane'ohe, Hawaii, and Dr. Amy R. Scholik, Geo-Marine., Inc., Hampton, Virginia, on 29 August 2006.

Mooney, T. A., P. E. Nachtigall, W. W. L. Au, M. Breese, and S. Vlachos, 2005. Bottlenose dolphin: Effects of noise duration, intensity, and frequency, in *Abstracts, Sixteenth Biennial Conference on the Biology of Marine Mammals*. 12–16 December 2005. San Diego, California. p 197.

Moore, F. R., S. A. Gauthreaux, P. Kerlinger, and T. R. Simons, 1995. Habitat requirements during migration: important link in conservation, in: *Ecology and Management of Neotropical Migratory Birds*, Martin, T. E., and D. M. Finch, eds. Oxford University Press Inc.: New York. pp 121–144.

Moore, J. C., 1951a. The range of the Florida manatee. *Quarterly Journal of the Florida Academy of Sciences*, Vol 14, No 1, pp 1–19.

Moore, J. C., 1951b. The status of the manatee in the Everglades National Park, with notes on its natural history. *Journal of Mammalogy*, Vol 32, No 1, pp 22–36.

Moore, J. C., 1953. Distribution of marine mammals to Florida waters. *American Midland Naturalist*, Vol 49, pp 117–158.

Moore, J. C., 1956. Observations of manatees in aggregations. *American Museum Novitates*, Vol 1811, pp 1–24.

Moore, P. W. B., and Schusterman, R. J., 1987. Audiometric assessment of northern fur seals, *Callorhinus ursinus*. *Marine Mammal Science*, Vol 3, pp 31–53.

Moore, T. C., 1999. *Estimation of the source signal characteristics and variability of blue whale calls using a towed array*. Master's thesis, Naval Postgraduate School.

Moreno, I. B., A. N. Zerbini, D. Danilewicz, M. C. de Oliveira Santos, P. C. Simões-Lopes, J. Lailson-Brito, Jr., and A. F. Azevedo, 2005. Distribution and habitat characteristics of dolphins of the genus *Stenella* (Cetacea: Delphinidae) in the southwest Atlantic Ocean. *Marine Ecology Progress Series*, Vol 300, pp 229–240.

Morreale, S. J., A. B. Meylan, and B. Baumann, 1989. Sea turtles in Long Island Sound, New York: an historical perspective, in *Proceedings of the Nineth Annual Workshop on Sea Turtle Conservation and Biology*, S. A.

Eckert, K. L. Eckert, and T. H. Richardson, eds., pp 121–123. U. S. Department Commerce, National Oceanic and Atmospheric Administration Technical Memo, National Marine Fisheries Service, Southeast Fisheries Center, NMFS-SEFC-232. pp 306.

Morreale, S. J., and E. A. Stnadora, 2005. Western North Atlantic waters: crucial developmental habitat for Kemp's ridley and loggerhead sea turtles. *Chelonian Conservation Biology*, Vol 4, pp 872–882.

Morreale, S. J., A. B. Meylan, S. S. Sadove, and E. A. Standora, 1992. Annual Occurrence and Winter Mortality of Marine Turtles in New York Waters. *Journal of Herpetology*, Vol 26, pp 301–308.

Morreale, S. J., and E. A. Standora, 1998. *Early life stage ecology of sea turtles in northeastern U.S. waters*. NOAA Technical Memorandum NMFS-SEFSC-413:1-49.

Morton, A. B., and H. K. Symonds, 2002. Displacement of *Orcinus orca* (L.) by high amplitude sound in British Columbia, Canada. *ICES Journal of Marine Science*, Vol 59, pp 71–80.

Mowbray, T. B., 2002. Northern Gannet (*Morus bassanus*)., in *The Birds of North America*, No. 693, A. Poole and F. Gill, eds. The Birds of North America, Inc: Philadelphia, PA.

Mrosovsky, N., 1980. Thermal biology of sea turtles. *American Zoologist*, Vol 20, No 3, pp 531–547.

Mrosovsky, N., 1972. Spectrographs of the sounds of leatherback turtles. *Herpetologica*, Vol 28, pp 256–258.

Mrosovsky, N., 1972. The water-finding ability of sea turtles: Behavioral studies and physiological speculation. *Brain Behavior and Evolution* Vol 5, pp 202–205.

Muller, M. J., and R. W. Storer, 1999. Pied-billed Grebe (*Podilymbus podiceps*), in *The Birds of North America,* No. 410, A. Poole and F. Gill, eds. The Birds of North America, Inc.: Philadelphia, PA.

Mullin, K. D., and W. Hoggard, 2000. Visual surveys of cetaceans and sea turtles from aircraft and ships, in *Cetaceans, Sea Turtles and Seabirds in the Northern Gulf of Mexico: Distribution, Abundance and Habitat Associations*, R. W. Davis, W. E. Evans, and D. Würsig, eds. Volume II: Technical Report. 11-172. OCS Study MMS 96-0027. Minerals Management Service, Gulf of Mexico OCS Region, New Orleans, LA 70123.

Mullin, K. D. and G. L. Fulling, 2003. Abundance of cetaceans in the southern U.S. North Atlantic Ocean during summer 1998. *Fishery Bulletin*, Vol 101, pp 603–613.

Mullin, K. D. and G. L. Fulling, 2004. Abundance of cetaceans in the oceanic northern Gulf of Mexico, 1996–2001. *Marine Mammal Science*, Vol 20, No 4, pp 787–807.

Mullin, K. D. and L. J. Hansen, 1999. Marine mammals of the northern Gulf of Mexico, in The Gulf of Mexico Large Marine Ecosystem: Assessment, Sustainability, and Management, Kumpf, H., K. Steidinger, and K. Sherman, eds. Blackwell Science: Cambridge, England. pp 269–277.

Mullin, K. D., L. V. Higgins, T. A. Jefferson, and L. J. Hansen, 1994a. Sightings of the Clymene dolphin (*Stenella clymene*) in the Gulf of Mexico. *Marine Mammal Science*, Vol 10, No 4, pp 464–470.

Mullin, K. D., W. Hoggard, and L. J. Hansen, 2004. Abundance and seasonal occurrence of cetaceans in outer continental shelf and slope waters of the north-central and northwestern Gulf of Mexico. *Gulf of Mexico Science*, Vol 22, No 1, pp 62–73.

Mullin, K. D., W. Hoggard, C. L. Roden, R. R. Lohoefener, C. M. Rogers, and B. Taggart, 1994b. Cetaceans on the upper continental slope in the north-central Gulf of Mexico. *Fishery Bulletin*, Vol 92, pp 773–786.

Muñoz-Hincapié, M. F., D. M. Mora-Pinto, D. M. Palacios, E. R. Secchi, and A. A. Mignucci-Giannoni, 1998. First osteological record of the dwarf sperm whale in Colombia, with notes on the zoogeography of *Kogia* in South America. *Revista Academia Colombiana de Ciencias*, Vol 22, No 8, pp 433–444.

Murphy, M. A., 1995. Occurrence and group characteristics of minke whales, *Balaenoptera acutorostrata*, in Massachusetts Bay and Cape Cod Bay. *Fishery Bulletin*, Vol 93, No 5, pp 585.

Musick, J. A., R. Byles, R. Klinger, and S. Bellmund. 1984. *Mortality and behavior of sea turtles in the Chesapeake Bay: Summary Report for 1979 through 1983.* Contract Report #NA80FA00004. Prepared for NMFS-NEFSC, Woods Hole, MA.

Musick, J. A., and C. J. Limpus, 1997. Habitat utilization and migration of juvenile sea turtles, in *The Biology of Sea Turtles*, P.L. Lutz and J.A. Musick, eds. CRC Press: Boca Raton, Florida. pp 137–163.

Myrberg, Jr., A. A., 1980. Fish bioacoustics: its relevance to the "not so silent world." *Environmental Biology of Fish*, Vol 5, No 4, pp 297–304.

Myrberg, Jr., A. A., 2001. The acoustical biology of elasmobranches. *Environmental Biology of Fishes*, Vol 60, pp 31–45.

Nachtigall, P. E., W. W. L. Au, J. L. Pawloski, and P. W. B. Moore, 1995. Risso's dolphin (*Grampus griseus*) hearing thresholds in Kaneohe Bay, Hawaii, in *Sensory Systems of Aquatic Mammals*, R. A. Kastelein, J. A. Thomas, and P. E. Nachtigall, eds. Woerden, The Netherlands: De Spil Publishers. pp 49–53.

Nachtigall, P. E., D. W. Lemonds, and H. L. Roitblat, 2000. Psychoacoustic studies of dolphin and whale hearing, in *Hearing by Whales and Dolphins*, Au, W.W.L., A.N. Popper, and R.R. Fay, eds. Springer-Verlag: New York. pp 330–363.

Nachtigall, P.E., T. A. Mooney, K. A. Taylor, L. A. Miller, M. H. Rasmussen, T. Akamatsu, J. Teilmann, M. Linnenschmidt, and G. A. Vikingsson, 2008. Shipboard measurements of the hearing of the white-beaked dolphin *Lagenorhynchus albirostris*. *Journal of Experimental Biology*, No. 211, pp 642–647.

Nachtigall, P. E., J. L. Pawloski, and W. W. L. Au, 2003. Temporary threshold shifts and recovery following noise exposure in the Atlantic bottlenosed dolphin (*Tursiops truncatus*). *Journal of the Acoustical Society of America*, Vol 113, No 6, pp 3425–3429.

Nachtigall, P. E., A. Ya. Supin, J. L. Pawloski, and W. W. L. Au, 2004. Temporary threshold shifts after noise exposure in a bottlenosed dolphin (*Tursiops truncatus*) measured using evoked auditory potentials. *Marine Mammal Science*, Vol 20, No 4, pp 673–687. Nachtigall, P. E., M. M. L. Yuen, T. A. Mooney, and K. A. Taylor, 2005. Hearing measurements from a stranded infant Risso's dolphin, *Grampus griseus*. *Journal of Experimental Biology*, Vol 208, pp 4181–4188.

National Aeronautics and Space Administration (NASA), 2003. *Final Environmental Assessment for AQM-37 Operations at the National Aeronautics and Space Administration Goddard Space Flight Center, Wallops Flight Facility*. June 2003.

National Aeronautics and Space Administration (NASA), 2007a. Wallops Flight Facility. Retrieved from http://www.nasa.gov/centers/wallops/home/index.html, on 15 June 2007.

National Aeronautics and Space Administration (NASA), 2007b. Wallops Flight Facility, Capabilities and Facilities. Retrieved from http://www.nasa.gov/centers/wallops/about/capabilities.html, on 15 June 2007.

National Aeronautics and Space Administration (NASA), 2007c. NASA's Shuttle and Rocket Missions: Launch Schedule. Retrieved from http://www.nasa.gov/missions/highlights/schedule_prt.htm, on 02 April 2007.

National Aeronautics and Space Administration (NASA), 2007d. Mission Support: Wallops Missions, Programs, and Projects. Retrieved from http://www.nasa.gov/centers/wallops/missions/index_prt.htm, on 02 April 2007.

National Audubon Society, Inc., 2008. Bermuda Petrel *(Pterodroma cahow).* Retrieved from http://audubon2.org/watchlist/viewSpecies.jsp?id=26**,** on 9 May 2008.

National Geographic Society, 2002. *Field Guide to the Birds of North America*. National Geographic Society: Washington D.C.

National Marine Fisheries Service (NMFS), 1991. *Final recovery plan for the humpback whale (*Megaptera novaeangliae*)*. Prepared by the Humpback Whale Recovery Team. Silver Spring, Maryland: National Marine Fisheries Service.

National Marine Fisheries Service (NMFS), 1994. Designated critical habitat; northern right whale. *Federal Register*, Vol 59, No 106, pp 28793–28808.

National Marine Fisheries Service (NMFS), 1995. Sea turtle conservation; restrictions applicable to shrimp trawl activities; Leatherback Conservation Zone. Final rule. *Federal Register*, Vol 60, No 178, pp 47713–47715.

National Marine Fisheries Service (NMFS), 1997. *Biological Opinion for Navy Activities Off the Southeastern United States along the Atlantic Coast*. Issued to the Department of the Navy, 15 May 1997. National Marine Fisheries Service, Office of Protected Resources, Silver Spring, Maryland, and NMFS/Southeast Regional Office, St. Petersburg, Florida.

National Marine Fisheries Service (NMFS), 1998. Designated critical habitat; green and hawksbill sea turtles. Final rule. *Federal Register*, Vol 63, No 170, pp 46693–46701.

National Marine Fisheries Service (NMFS), 1998a. *Draft recovery plan for the fin whale* Balaenoptera physalus *and sei whale* Balaenoptera borealis. Prepared by R.R. Reeves, G.K. Silber, and P.M. Payne for the National Marine Fisheries Service, Silver Spring, Maryland.

National Marine Fisheries Service (NMFS), 1998b. *Recovery plan for the blue whale (*Balaenoptera musculus*).* Prepared by R.R. Reeves, P.J. Clapham, R. L. Brownell, Jr., and G. K. Silber for the National Marine Fisheries Service, Silver Spring, Maryland.

National Marine Fisheries Service (NMFS), 1998c. Designated critical habitat; green and hawksbill sea turtles. Final Rule. *Federal Register*, Vol 63, No 170, pp 46693–46701.

National Marine Fisheries Service (NMFS), 2000. Sea turtle conservation; Restrictions applicable to shrimp trawl activities; Leatherback Conservation Zone. *Federal Register* Vol 65, No 102, pp 33779–33780.

National Marine Fisheries Service (NMFS), 2001a. *Final review of the biological status of the Gulf of Maine/Bay of Fundy harbor porpoise (*Phocoena phocoena*) pursuant to the Endangered Species Act*. Silver Spring, Maryland: National Marine Fisheries Service.

National Marine Fisheries Service (NMFS), 2001b. *Final U.S. National Plan of Action for Reducing the Incidental Catch of Seabirds in Longline Fisheries*. U.S. Department of Commerce, NOAA, NMFS. Silver Spring, MD. February 2001.

National Marine Fisheries Service (NMFS), 2002a. *Endangered Species Act (ESA) Section 7 Consultation on Mine Warfare Exercises (MINEX) and Explosive Ordnance Disposal (EOD) Unit Level Training at Several Locations Along the East Coast of the United States*. October 2002.

National Marine Fisheries Service (NMFS), 2002b. Listing endangered and threatened wildlife and designating critical habitat; 90-day finding for a petition to reclassify the Northern and Florida Panhandle subpopulations of the loggerhead as distinct population segments with endangered status and to designate critical habitat. *Federal Register*, Vol 67, No 107, pp 38459–38461.

National Marine Fisheries Service (NMFS), 2003a. *Environmental Assessment on the Effects of Scientific Research Activities Associated with Development of a Low-Power High-Frequency Sonar System to Detect Marine Mammals*. December 2003.

National Marine Fisheries Service (NMFS), 2003b. Endangered and threatened species; final endangered status for a distinct population segment of smalltooth sawfish (*Pristis pectinata*) in the United States. *Federal Register,* Vol 68, No 62, pp 15674–15680.

National Marine Fisheries Service (NMFS), 2005a. NOAA Recreational Fisheries Strategic Plan FY2005 – FY2010. Retrieved from http://www/nmfs/noaa.gov/recfish/Fisheries_Strategic_Plan.pdf, on 27 September 2007.

National Marine Fisheries Service (NMFS), 2005b. *Recovery plan for the North Atlantic right whale (*Eubalaena glacialis*)*. Silver Spring, Maryland: National Marine Fisheries Service.

National Marine Fisheries Service (NMFS), 2005c. *Assessment of Acoustic Exposures on Marine Mammals in Conjunction with USS Shoup Active Sonar Transmissions in the Eastern Strait of Juan de Fuca and Haro Strait*. National Marine Fisheries Service, Office of Protected Resources, Washington, 5 May 2003.

National Marine Fisheries Service (NMFS), 2006a. *Environmental Impact Statement to Implement the Operational Measures of the North Atlantic Right Whale Ship Strike Reduction Strategy, Draft Environmental Impact Statement*. Retrieved from http://www.nmfs.noaa.gov/pr/pdfs/shipstrike/deis.pdf, on 27 September 2007.

National Marine Fisheries Service (NMFS), 2006b. *Draft U.S. Atlantic marine mammal stock assessments - 2006*. Silver Spring, Maryland: National Marine Fisheries Service.

National Marine Fisheries Service (NMFS), 2006c. *Review of the status of the right whales in the North Atlantic and North Pacific oceans*. Report prepared by the various offices of the National Marine Fisheries Service.

National Marine Fisheries Service (NMFS), 2006d. Smalltooth Sawfish (*Pristis pectinata*). NOAA Fisheries Office of Protected Resources. Retrieved from http://www.nmfs.noaa.gov/pr/species/fish/smalltooth sawfish.htm, in December 2006.

National Marine Fisheries Service (NMFS), 2006e. *Draft recovery plan for the sperm whale (*Physeter macrocephalus*)*. Silver Spring, Maryland: National Marine Fisheries Service.

National Marine Fisheries Service (NMFS), 2006f. Taking of marine mammals incidental to commercial fishing operations; Bottlenose Dolphin Take Reduction Plan regulations; Sea turtle conservation; Restrictions to fishing activities--Final rule. *Federal Register*, Vol 71, No 80, pp 24776–24797.

National Marine Fisheries Service (NMFS), 2006g. Notice; receipt of application and proposed authorization for incidental harassment of marine mammals; request for comments and information for the Small Takes of Marine Mammals Incidental to Specified Activities; Naval Explosive Ordnance Disposal School Training Operations at Eglin Air Force Base, Florida. *Federal Register*, Department of Commerce; NOAA Fisheries. 1 August 2006. *Federal Register*, Vol 71, No 147, pp 43470–43474.

National Marine Fisheries Service (NMFS), 2006h. Taking and Importing Marine Mammals; Taking Marine Mammals Incidental to the Explosive Removal of Offshore Structures in the Gulf of Mexico. National Marine Fisheries Service, National Oceanic and Atmospheric Administration, Department of Commerce. 7 April 2006. *Federal Register*, Vol 71, No 67. Document obtained at http://frwebgate2.access.gpo.gov/cgi-bin/waisgate.cgi?WAISdocID=524976171714 +0+0+0&WAISaction=retrieve, on 30 May 2007.

National Marine Fisheries Service (NMFS), 2006i. *Biological Opinion for Sinking Exercises (SINKEX) in the Western North Atlantic Ocean*. September.

National Marine Fisheries Service (NMFS). 2006j. *Draft recovery plan for the fin whale (*Balaenoptera physalus*)*. Silver Spring, Maryland: National Marine Fisheries Service.

National Marine Fisheries Service (NMFS), 2006k. Final Rule for the Taking and Importing Marine Mammals; Taking Marine Mammals Incidental to Conducting Precision Strike Weapons Testing and Training by Eglin Air Force Base in the Gulf of Mexico. *Federal Register*, Department of Commerce: NOAA Fisheries. 24 November 2006. *Federal Register*, Vol 71, No 226, pp 67810–67824.

National Marine Fisheries Service (NMFS), 2007a. Concurrence on torpedo exercises proposed in the Cape Cod Operating Area between August and December 2007 and 2008 are not likely to adversely affect endangered or threatened species under NMFS' jurisdiction. September.

National Marine Fisheries Service (NMFS), 2007c. NMFS Annual Commercial Landings Statistics between 1996 and 2006. Retrieved from http://www.st.nmfs.noaa.gov/st1/commercial/landings/annual_landings.html on 03 December 2007.

National Marine Fisheries Service (NMFS), 2007d. NMFS Annual Commercial Landings by Group in 2006. Retrieved from http://www.st.nmfs.noaa.gov/st1/commercial/landings/gc_runc.html on 03 December 2007.

National Marine Fisheries Service (NMFS), 2007e. NMFS 2006 U.S. Landings by Distance from Shore. Retrieved from http://www.st.nmfs.noaa.gov/st1/commercial/landings/ds_8850_bystate.html on 03 December 2007.

National Marine Fisheries Service (NMFS), 2007f. NMFS 2006 Annual Commercial Landings by Gear Type. Retrieved from http://www.st.nmfs.noaa.gov/st1/commercial/landings/gear_landings.html on 03 December 2007.

National Marine Fisheries Service (NMFS) 2007g. Recreational Fishery Statistics Catch Snapshot Query. NOAA Fisheries: Office of Science and Technology. Obtained from www.st.nmfs.noaa.gov/st1/ recreastional/queries/catch/snapshot.html

National Marine Fisheries Service (NMFS), 2007h. *Biological Opinion for the USS Truman 07-1 Combined Carrier Strike Group Composite Training Unit/Joint Task Force Exercise*.

National Marine Fisheries Service (NMFS), 2007i. Taking and Importing Marine Mammals; Taking Marine Mammals Incidental to the U.S. Navy Operations of Surveillance Towed Array Sensor System Low Frequency Active Sonar; Final Rule, 21 August 2007. *Federal Register*, Vol 68, No 161.

National Marine Fisheries Service (NMFS), 2007j. *Draft Programmatic Environmental Impact Statement for the Marine Mammal Health and Stranding Response Program*, p. 1006.

National Marine Fisheries Service (NMFS), 2007k. Taking of Marine Mammals Incidental to Commercial Fishing Operations; Atlantic Large Whale Take Reduction Plan Regulations. *Federal Register*, Vol 72, No 227.

National Marine Fisheries Service (NMFS), 2008a. *National Marine Fisheries Office of Protected Resources Memorandum to Chief of Naval Operations, Environmental Readiness*. January 19, 2008.

National Marine Fisheries Service (NMFS), 2008b. *Endangered Species Act Section 7 Consultation, Biological Opinion, for the U.S. Navy's proposal to conduct four training exercises in the Cherry Point, Virginia Capes, and Jacksonville Range Complexes between spring and winter 2008*. April.

National Marine Fisheries Service (NMFS), 2008c. Taking and Importing Marine Mammals; Atlantic Fleet Active Sonar Training; Notice; Receipt of Application for Letter of Authorization; Request for Comments and Information. 5 March 2008. *Federal Register*, Vol 73, No 44.

National Marine Fisheries Service (NMFS), 2008d. Taking of Marine Mammals Incidental to Commercial Fishing Operations; Atlantic Large Whale Take Reduction Plan Regulations. *Federal Register*, Vol 73, No 170.

National Marine Fisheries Service (NMFS), 2008e. *Final Environmental Impact Statement to Implement Vessel Operational Measures to Reduce Ship Strikes to North Atlantic Right Whales*. August 2008.

National Marine Fisheries Service (NMFS), 2008f. Taking and Importing Marine Mammals; U.S. Navy's Atlantic Fleet Active Sonar Training; Proposed Rule. *Federal Register*, Vol 73, No 199, pp 60754 – 60833.

National Marine Fisheries Service (NMFS), 2008g. Marine mammal unusual mortality events. Retrieved from http://www.nmfs.noaa.gov/pr/health/mmume/, on October 20, 2008.

National Marine Fisheries Service (NMFS). 2008h. 2008 Texas bottlenose dolphin (*Tursiops truncatus*) unusual mortality event. Retrieved from http://www.nmfs.noaa.gov/pr/health/mmume/texas2008.htm, on October 20, 2008.

National Marine Fisheries Service (NMFS), 2008i. Endangered Fish and Wildlife; Final Rule to Implement Speed Restrictions to Reduce the Threat of Ship Collisions with North Atlantic Right Whales. *Federal Register*, Vol. 73, No. 198, pp 60173–60191.

National Marine Fisheries Service (NMFS) and U.S. Fish and Wildlife Service (USFWS), 1991. *Recovery plan for U.S. population of Atlantic green turtle (*Chelonia mydas*)*. St. Petersburg, Florida: National Marine Fisheries Service.

National Marine Fisheries Service (NMFS), and U.S. Fish and Wildlife Service (USFWS), 1992. *Recovery plan for leatherback turtles in the U.S. Caribbean, Atlantic and Gulf of Mexico*. Washington, D.C.: National Marine Fisheries Service.

National Marine Fisheries Service (NMFS) and U.S. Fish and Wildlife Service (USFWS), 2007. *Hawksbill sea turtle (*Eretmochelys imbricata*) 5-year review: summary and evaluation*. National Marine Fisheries Service: Silver Spring, Maryland, and U.S. Fish and Wildlife Service: Jacksonville, Florida.

National Marine Fisheries Service-Northeast Fisheries Science Center (NMFS-NEFSC), 2008. Northeast U.S. Right Whale Sighting Advisory System. Retrieved from http://rwhalesightings.nefsc.noaa.gov/, on 6 June 2008.

National Marine Fisheries Service, Southeast Fisheries Science Center (NMFS-SEFSC), 1999. C*ruise results, summer Atlantic Ocean marine mammal survey, NOAA Ship Oregon II cruise OT 99-05 (236)*. Unpublished cruise report. Pascagoula, Mississippi: National Marine Fisheries Service.

National Marine Fisheries Service, Southeast Fisheries Science Center (NMFS-SEFSC), 2001a. *Preliminary stock structure of coastal bottlenose dolphins along the Atlantic coast of the US*. Unpublished document prepared for the Take Reduction Team on Coastal Bottlenose Dolphins in the Western Atlantic.

National Marine Fisheries Service, Southeat Fisheries Science Center (NMFS-SEFSC), 2001b. *Stock assessments of loggerhead and leatherback sea turtles and an assessment of the impact of the pelagic longline fishery on the loggerhead and leatherback sea turtles of the Western North Atlantic*. U. S. Department of Commerce. NOAA Technical Memorandum. NMFS-SEFSC-455. 343pp.

National Marine Fisheries Service-Southeast Fisheries Science Center (NMFS-SEFSC), 2005. Geographic coordinates for sea turtles strandings in North Carolina from 1998-2005. Data received May 2006 from Ms. Wendy Teas. Miami, Florida: National Marine Fisheries Service, Southeast Fisheries Science Center.

National Ocean Industries Associaton (NOIA), 2006. *Washington Report*, Vol XXXIV, No 7. 19 July 2006.

National Oceanic and Atmospheric Administration (NOAA), 2006. *Draft Environmental Impact Statement to Implement the Operational Measures of the North Atlantic Right Whale Ship Strike Reduction Strategy*. July 2006.

National Oceanic and Atmospheric Administration (NOAA) and Florida Fish and Wildlife Conservation Commission (FWC), 2004. *Interim report on the bottlenose dolphin (*Tursiops truncatus*) unusual mortality event along the panhandle of Florida March-April 2004*.

National Oceanic and Atmospheric Administration (NOAA) and Florida Fish and Wildlife Conservation Commission (FWC), 2006. NOAA and FWC confirm right whales off Florida Gulf Coast. Press Release. St. Petersburg, Florida: Florida Fish and Wildlife Conservation Commission - 28 February.

National Oceanic and Atmospheric Administration (NOAA) Ocean Explorer, 2008. Technical Diving. Retrived from http://www.oceanexplorer.noaa.gov/technology/diving/technical/technical.html on May 27, 2008.

National Oceanic and Atmospheric Administration (NOAA), 1993. *The Stellwagen Bank National Marine Sanctuary Management Plan -- 1993 Plan*. Retrieved from http://stellwagen.noaa.gov/management/1993plan/mp1993.html, on May 28, 2004

National Oceanic and Atmospheric Administration (NOAA), 1998. December 1, 1998. Final Rule for the incidental taking of marine mammals, Naval activities; USS Seawolf submarine shock testing. *Federal Register*, Vol 63, No 230, 66069–66077.

National Oceanic and Atmospheric Administration (NOAA), 1999. *Acoustic Criteria Workshop*. National Marine Fisheries: Silver Spring, Maryland.

National Oceanic and Atmospheric Administration (NOAA), 2001. Final Rule for the Shock Trial of the WINSTON S. CHURCHILL (DDG-81), Federal Register, Department of Commerce; NOAA National Marine Fisheries Service. *Federal Register*, Vol 66, No 87, 22450–22467, 4 May.

National Oceanic and Atmospheric Administration (NOAA), 2002a. Final Rule SURTASS LFA Sonar. Department of Commerce, NOAA National Marine Fisheries Service. 16 July 2002. *Federal Register*, Vol 67, No 136, pp 46712–46789.

National Oceanic and Atmospheric Administration (NOAA), 2002b. *Report of the workshop on acoustic resonance as a source of tissue trauma in cetaceans*. NOAA National Marine Fisheries Service, Silver Spring, Maryland. April 2002.

National Oceanic and Atmospheric Administration (NOAA), 2004. NOAA Partners with Fishery Organizations, Academia, and Private Industry to Develop New Technologies that Save Sea Turtles. *NOAA Magazine.* Retrieved from http://www.magazine.noaa.gov/stories/mag144.htm, on 23 May 2008.

National Oceanic and Atmospheric Administration (NOAA), 2006a. *Flower Garden Banks.* National Oceanic Atmospheric Administration, State of the Sanctuary Report.

National Oceanic and Atmospheric Administration (NOAA), 2006b. NOAA proposes regulations to reduce risk of whale collisions. *Marine Pollution Bulletin*, Vol 52, p 837.

National Oceanic and Atmospheric Administration (NOAA), 2006c. Proposed Rule Taking and Importing Marine Mammals; Taking Marine Mammals Incidental to Conducting Precision Strike Weapons Testing and Training by Eglin Air Force Base in the Gulf of Mexico, Department of Commerce, NOAA National Marine Fisheries Service, *Federal Register*, Vol 71, No 149, pp 44001–44012. 3 August 2006.

National Oceanic and Atmospheric Administration (NOAA), 2006d. Draft Environmental Impact Statement to Implement the Operational Measures of the North Atlantic Right Whale Ship Strike Reduction Strategy. July, 2006.

National Oceanic and Atmospheric Administration (NOAA), 2006e. NOAA proposes regulations to reduce risk of whale collisions. *Marine Pollution Bulletin* Vol 52, p 837.

National Oceanic and Atmospheric Administration (NOAA), 2006f. Wandering Hooded Seals Puzzle and Challenge NOAA's Stranding Network. Retrieved from http://www.noaanews.noaa.gov/stories2006/s2705.htm, on 18 December 2006.

National Oceanic and Atmospheric Administration (NOAA), 2007a. Marine Debris Program. Retrieved from http://marinedebris.noaa.gov/about/welcome.html, on 23 September 2007.

National Oceanic and Atmospheric Administration (NOAA), 2007b. NOAA & Coast Guard Help Shift Boston Ship Traffic Lane to reduce Risk of Collision with Whales. Retrieved from http://www.nmfs.noaa.gov/pr/pdfs/shipstrike/boston_press_release.pdf, on 27 September 2007.

National Oceanic and Atmospheric Administration (NOAA), 2007c. Gray's Reef National Marine Sanctuary website. Retrieved from http://graysreef.noaa.gov/about.html, on 27 June 2007.

National Oceanic and Atmospheric Administration (NOAA), 2007d. Florida Keys National Marine Sanctuary website. Retrieved from http://floridakeys.noaa.gov/welcome.html, on 27 June 2007.

National Oceanic and Atmospheric Administration (NOAA), 2007e. Flower Garden Banks National Marine Sanctuary website. Retrieved from http://flowergarden.noaa.gov/about/about.html, on 27 June 2007.

National Oceanic and Atmospheric Administration (NOAA), 2007f. Monitor National Marine Sanctuary. Retrieved from http://sanctuaries.noaa.gov/visit/pdfs/monitor.pdf, on 19 June 2007.

National Oceanic and Atmospheric Administration (NOAA), 2007g. National Marine Sanctuary Program (NMSP), *The National Marine Sanctuaries Act*. Retrieved from http://sanctuaries.noaa.gov/about/legislation/, on 21 September 2007.

National Oceanic and Atmospheric Administration (NOAA), 2007h. Florida Keys National Marine Sanctuary Submerged Cultural Resources. Retrieved from http://floridakeys.noaa.gov/sanctuary_resources/scr.html, on 19 June 2007.

National Oceanic and Atmospheric Administration (NOAA), 2007i. Florida Keys National Marine Sanctuary Shipwreck Trail. http://floridakeys.noaa.gov/sanctuary_resources/shipwreck_trail/welcome.html.

National Oceanic and Atmospheric Administration (NOAA), 2008. Strategy to Reduce Ship Strikes to North Atlantic Right Whales: Shift of the Boston Traffic Separation Scheme. Retrived from http://www.nmfs.noaa.gov/pr/shipstrike/ on 16 May 2008.

National Oceanic and Atmospheric Administration Pacific Marine Environmental Laboratory, 2007 Acoustic Monitoring Project. Retrieved from http://oceanexplorer.noaa.gov/explorations/sound01/background/acoustics/acoustics.html, on 7 June 2007.

National Park Service (NPS), 2003. First Kemp's ridley sea turtle nest at Cape Lookout National Seashore. Retreived from http://www.nps.gov/archive/calo/press062003.htm., on 31 January 2007.

National Park Service (NPS), 2006. Padre Island National Seashore, 2006 Sea turtle nesting season. Retrieved from http://www.nps.gov/archive/pais/website/current_season.htm., on 8 November 2006

National Park Service, 2007. Kemp's website. Retreived from http://www.nps.gov/pais/naturescience/kridley.htm, on 15 June 2007.

National Research Council (NRC), 1997. Information is as printed in: *The National Marine Fisheries Service's biological opinion regarding the effects of the U.S. Navy's proposed 2006 RIMPAC Naval exercise, pg 48, June 27, 2006*.

National Research Council (NRC), 2003. *Ocean Noise and Marine Mammals*. Prepared by the Committee on Potential Impacts of Ambient Noise in the Ocean on Marine Mammals, Ocean Studies Board, Division on Earth and Life Studies. The National Academies Press: Washington D.C.

National Research Council (NRC), 2005. *Marine Mammal Populations and Ocean Noise: Determining When Noise Causes Biologically Significant Effects*. The National Academic Press, Washington D.C. 126 pp.

National Research Council (NRC), 2006. *Dynamic Changes in Marine Ecosystems: Fishing, Food Webs, and Future Options, Committee on Ecosystem Effects of Fishing: Phase II - Assessments of the Extent of Change and the Implications for Policy.* National Research Council, of the National Academes, National Academes Press: Washington, DC.

Natoli, A., V. M. Peddemors, and A. R. Hoelzel, 2004. Population structure and speciation in the genus *Tursiops* based on microsatellite and mitochondrial DNA analyses. *Journal of Evolutionary Biology*, Vol 17, pp 363–375.

Naval Facilities Engineering Command, Southwest Division, 1993. *Report on Continuing Action: Standard Range Sonobuoy Quality Assurance Program*. San Clemente Island, California. Program Executive Office, Antisubmarine Warfare Assault and Special Mission Programs. September 1993.

Naval Sea Systems Command (NAVSEA), 2007. Navy Inactive Ship Program. Retrieved from http://peoships.crane.navy.mil/inactiveships/SINKEX/FAQ_sinkex.htm, on 17 December 2007.

Nawojchik, R., D. J. St. Aubin, and A. Johnson, 2003. Movements and dive behavior of two stranded, rehabilitated long-finned pilot whales (*Globicephala melas*) in the northwest Atlantic. *Marine Mammal Science*, Vol 19, pp 232–239.

Nedwell, J. R., B. Edwards, A. W. H. Turnpenny, and J. Gordon, 2004. *Fish and Marine Mammal Audiograms: A Summary of Available Information Subacoustech Report Reference*.

Nelson, J. S., 1994. *Fishes of the World*. John Wiley and Sons: New York.

Nelson, J. S., E. J. Crossman, H. Espinosa-Pérez, L. T. Findley, C. R. Gilbert, R. N. Lea, and J. D. Williams, 2004. Common and scientific names of fishes from the United States, Canada, and Mexico, 6th ed. *American Fisheries Society Special Publication*, Vol 29.

Nelson M., M. Garron, R. L. Merrick, R. M. Pace III, and T. V. N. Cole, 2007. Mortality and serious injury determinations for baleen whale stocks along the United States eastern seaboard and adjacent Canadian Maritimes, 2001-2005. U.S. Department of Commerce, *Northeast Fisheries Science Center Reference Doc*. 07-05; 18 p.

Nemoto, T., and A. Kawamura, 1977. Characteristics of food habits and distribution of baleen whales with special reference to the abundance of North Pacific sei and Bryde's whales. *Reports of the International Whaling Commission*, Special Issue 1, pp 80–87.

Nestler, J. M., R. A. Goodwin, T. M. Cole, D. Degan, and D. Dennerline, 2002. Simulating movement patterns of blueback herring in a stratified Southern impoundment. *Transactions of the American Fisheries Society*, Vol 131, pp 55–69.

Neuhauser, H., ed., 2007. *Right Whale News*, Vol 14, No 4.

Ng, S.L. and S. Leung, 2003. Behavioral response of Indo-Pacific humpback dolphin (*Sousa chinensis*) to vessel traffic. *Marine Mammal Research*, Vol 56, No 5, pp 555–567.

Niezrecki, C., R. Phillips, M. Meyer, and D.O. Beusse, 2003. Acoustic detection of manatee vocalizations. *Journal of the Acoustical Society of America*, Vol 114, No 3, pp 1640–1647.

Nishiwaki, M., 1966. Distribution and migration of the larger cetaceans in the North Pacific, shown by Japanese whaling results, in *Whales, Dolphins, and Porpoises*, K. S. Norris, ed. University of California Press: Berkeley. pp 171–191.

Norman, S. A., S. Raverty, W. McClellan, A. Pabst, D. Ketten, M. Fleetwood, J. K. Gaydos, B. Norberg, L. Barre, T. Cox, B. Hanson, and S. Jeffries, 2004. *Multidisciplinary investigation of stranded harbor porpoises (*Phocoena phocoena*) in Washington State with an assessment of acoustic trauma as a contributory factor (2 May – 2 June 2003).* U.S. Department of Commerce, NOAA Tech Memo NMFS-NWR-34. pp 120.

Norris, K. S., and T. P. Dohl, 1980. Behavior of the Hawaiian spinner dolphin, *Stenella longirostris*. *Fishery Bulletin*, Vol 77, No 4, pp 821–849.

Northeast Gateway, 2007. Northeast gateway Project Overview. Retrieved from http://www.northeastgateway.com/overview/overview.php, on 17 October 2007.

Northeast Gateway, 2008. Northeast Gateway Deepwater Port. Retrieved from http://www.excelerateenergy.com/downloads/Excelerate_northeastgateway.pdf, on 16 May 2008.

Northridge, S. P., and R. J. Hofman, 1999. Marine mammal interactions with fisheries, in *Conservation and Management of Marine Mammals*, J. R. Twiss, Jr. and R. R. Reeves, eds. Smithsonian Institution Press: Washington, D.C. pp 99–119.

Northridge, S., 1996. Seasonal distribution of harbour porpoises in US Atlantic waters. *Reports of the International Whaling Commission*, Vol 46, pp 613–617.

Northridge, S., M. Tasker, A. Webb, K. Camphuysen, and M. Leopold, 1997. White-beaked *Lagenorhynchus albirostris* and Atlantic white-sided dolphin *L. acutus* distributions in northwest European and US North Atlantic waters. *Reports of the International Whaling Commission*, Vol 47, pp 797–805.

Notarbartolo di Sciara, G., 1982. *Bryde's whales (*Balaenoptera edeni *Anderson, 1878) off eastern Venezuela (Cetacea, Balaenopteridae).* Technical Report 83-153. San Diego, California: Hubbs-Sea World Research Institute.

Nowacek, D. P., 2005. Acoustic ecology of foraging bottlenose dolphins (*Tursiops truncatus*), habitat-specific use of three sound types. *Marine Mammal Science*, Vol 21, No 4, pp 587–602.

Nowacek, D. P., B. M. Casper, R. S. Wells, S. M. Nowacek, and D. A. Mann, 2003. Intraspecific and geographic variation of West Indian manatee (*Trichechus manatus spp.*) vocalizations (L). *Journal of the Acoustical Society of America*, Vol 114, No 1, pp 66–69.

Nowacek, D. P., L. H. Thorne, D. W. Johnston, and P. L. Tyack, 2007. Responses of cetaceans to anthropogenic noise. *Mammal Review*, Vol 37, No 2, pp 81–115.

Nowacek, D. P., M. P. Johnson, and P. L. Tyack, 2004. North Atlantic right whales (*Eubalaena glacialis*) ignore ships but respond to alerting stimuli. *Proceedings of the Royal Society B: Biological Sciences*, Vol 271, pp 227–231.

O'Corry-Crowe, G.M., 2002. Beluga whale *Delphinapterus leucas,* in *Encyclopedia of Marine Mammals*, W.F. Perrin, B. Würsig, and J.G.M. Thewissen, eds. Academic Press: San Diego. pp 94-99.

O'Hara, J., and J. R. Wilcox, 1990. Avoidance responses of loggerhead turtles, *Caretta caretta*, to low frequency sound. *Copeia*, Vol 1990, pp 564–567.

O'Sullivan, S. O. and K. D. Mullin, 1997. Killer whales (*Orcinus orca*) in the northern Gulf of Mexico. *Marine Mammal Science*, Vol 13, No 1, pp 141–147.

Ocean Conservancy, 2005. *International Coastal Cleanup: Summary Report for the United States*. The Ocean Conservancy: Washington D.C.

Ocean Pods, 2007. Aquacultured Copepods for the Hobbyist. Frequently Asked Questions. Retreived from http://www.oceanpods.com/faq.html, on December 3, 2007.

Ocean Renewable Power Company, LLC (ORPC), 2007. Ocean Renewable Power Company. Retrieved from http://www.oceanrenewablepower.com/, on 24 July 2007.

Ocean Renewable Power Company, 2008a. Application for Preliminary Permit for the West Palm Beach OCGEN™ Power Project. March 2008. Available at http://www.ferc.gov/industries/hydropower/indus-act/hydrokinetics/permits-pending.asp#skipnavsub.

Ocean Renewable Power Company, 2008b. Application for Preliminary Permit for the Ft. Lauderdale OCGEN™ Power Project. March 2008. Available at http://www.ferc.gov/industries/hydropower/indus-act/hydrokinetics/permits-pending.asp#skipnavsub.

Occupational Safety and Health Administration, 1996. Occupational Exposure to 1,3-Butadiene; Final Rule. *Federal Register*, Vol 61, No. 214, pp 56746–56795.

Occupational Safety and Health Administration 2006. Occupational Exposure to Hexavalent Chromium", *Federal Register*, Vol 71, No. 39, pp 10099–10385.

Odell, D. K., 1987. The mystery of marine mammal strandings. *Cetus*, Vol 7, pp 2.

Odell, D. K., and K. M. McClune, 1999. False killer whale *Pseudorca crassidens* (Owen, 1846), in *Handbook of Marine Mammals, Vol 6: The Second Book of Dolphins and the Porpoises*, S. H. Ridgway and R. Harrison, eds. Academic Press: San Diego, California. pp 213–243.

Oey, L.-Y., T. Ezer, and H. C. Lee, 2005. *Loop Current, Rings and Related Circulation in the Gulf of Mexico: A Review of Numerical Models and Future Challenges*. Program in Atmospheric and Oceanic Sciences, Princeton University, Princeton, New Jersey.

Øien, N., 1990. Estimates of g(0) for minke whales based on an independent observer experiment during the Norwegian sightings surveys in July 1988. *Reports of the International Whaling Commission*, Vol 40, pp 331–335.

Oleson, E. M., J. Barlow, J. Gordon, S. Rankin, and J. A. Hildebrand, 2003. Low frequency calls of Bryde's whales. *Marine Mammal Science*, Vol 19, No 2, pp 407–419.

Olsen, K., 1990. Fish behaviour and acoustic sampling. Rapports et Procès-Verbaux des Réunions du Conseil International pour l'Exploration de la Mer, Vol 189, pp 147-58.

Olsen, K., J. Angell, F. Petterson, and A. Lovik, 1983. Observed fish reactions to a survey vessel with special reference to herring, cod, capelin and polar cod. *FAO Fisheries Report*, Vol 300, pp 131–138.

Ona, E., 1988. *Observations of Cod Reaction to Trawling Noise*. Fisheries Acoustics, Science and Technology Working Group, FAST.WG.Oostende, April 20–22, 1988.

Ortiz, R. M., and Worthy, G. A. J., 2000. Effects of capture on adrenal steroid and vasopressin concentrations in free-ranging bottlenose dolphins (*Tursiops truncatus*), *Journal of Comparative Biochemical Physiology A,* Vol 125, pp 317–324.

Oswald, J. N., J. Barlow, and T. F. Norris, 2003. Acoustic identification of nine delphinid species in the eastern tropical Pacific Ocean. *Marine Mammal Science*, Vol 19, No 1, pp 20–37.

Overholtz, W. J. and G. T. Waring, 1991. Diet composition of pilot whales *Globicephala* sp. and common dolphins *Delphinus delphis* in the Mid-Atlantic Bight during spring 1989. *Fishery Bulletin*, Vol 89, No 4, pp 723–728.

Overstrom, N. A., S. Spotte, J. L. Dunn, A. D. Goren, and H. W. Kaufman, 1991. A resident belukha whale (*Delphinapterus leucas*) in Long Island Sound, in *Marine Mammal Strandings in the United States*, J.E. Reynolds III and D.K. Odell, eds. Proceedings of the Second Marine Mammal Stranding Workshop, Miami, Florida. December 3-5, 1987. NOAA Technical Report NMFS-98. pp 143–149.

Pabst, D. A., S. A. Rommel, and W. A. McLellan, 1999. The functional morphology of marine mammals in *Biology of Marine Mammals*, J.E. Reynolds III and S.A. Rommel, eds. Smithsonian Institution: Washington, D.C. pp 15–72.

Palka, D., 1996. *Update on abundance of Gulf of Maine/Bay of Fundy harbor porpoises*. Northeast Fisheries Science Center Reference Document 96-04. Woods Hole, Massachusetts: National Marine Fisheries Service.

Palka, D. 2005a. Shipboard surveys in the northwest Atlantic: Estimation of g(0). *European Cetacean Society Newsletter*, Vol 44 (Special Issue), pp 32–37.

Palka, D. 2005b. Aerial surveys in the northwest Atlantic: Estimation of g(0). *European Cetacean Society Newsletter*, Vol 44 (Special Issue), pp 12–17.

Palka, D., 1995. Influences on spatial patterns of Gulf of Maine harbor porpoises, in *Whales, Seals, Fish and Man*, Blix, A. S., L. Walløe, and O. Ulltang, eds. Elsevier Science B.V.: New York. pp 69–75.

Palka, D., 2000. *Abundance of the Gulf of Maine/Bay of Fundy harbor porpoise based on shipboard and aerial surveys during 1999*. Northeast Fisheries Science Center Reference Document 00-07. Woods Hole, Massachusetts: National Marine Fisheries Service.

Palka, D., A. Read, and C. Potter, 1997. Summary of knowledge of white-sided dolphins (*Lagenorynchus acutus*) from the US and Canadian Atlantic waters. *Reports of the International Whaling Commission*, Vol 47, pp 729–734.

Palka, D. L. 2006. *Summer abundance estimates of cetaceans in US North Atlantic Navy operating areas*. Northeast Fisheries Science Center Reference Document 06-03. Woods Hole, Massachusetts: National Marine Fisheries Service.

Palmer, R. S., 1962. *Handbook of North American Birds, Vol. 1*. Yale Univ. Press, New Haven, CT.

Panigada, S., M. Zanardelli, S. Canese, and M. Jahoda, 1999. Deep diving performances of Mediterranean fin whales, in *Abstracts, Thirteenth Biennial Conference on the Biology of Marine Mammals*. 28 November–3 December 1999. Wailea, Maui, Hawaii. p 144.

Parks, S., and C. Clark, 2006. Seasonal and diurnal variation in North Atlantic right whale sound production from ARU recordings, in *Report of the Second Workshop on Right Whale Acoustics: Practical Applications in Conservation,* Leaper, R., and D. Gillespie, eds., pp 7–8.

Parks, S. E. and C. W. Clark, 2007. Acoustic communication: Social sounds and the potential impacts of noise, in *The Urban Whale: North Atlantic Right Whales at the Crossroads*, Kraus, S.D. and R.M. Rolland, eds. Harvard University Press: Cambridge, Massachusetts. pp 310–332.

Parks, S. E., and P. L. Tyack, 2005. Sound production by North Atlantic right whales (*Eubalaena glacialis*) in surface active groups. *Journal of the Acoustical Society of America*, Vol 117, No 5, pp 3297–3306.

Parks, S. E., C. W. Clark, and P. L. Tyack, 2007. Short- and long-term changes in right whale calling behavior: The potential effects of noise on acoustic communication, *Journal of the Acoustical Society of America*, Vol 122, pp 3725–3731.

Parks, S. E., D. R. Ketten, J. Trehey O'Malley, and J. Arruda, 2004. Hearing in the North Atlantic right whale: Anatomical predictions. *Journal of the Acoustical Society of America*, Vol 115, 5, Part 2, p 2442.

Parks, S. E., P. K. Hamilton, S. D. Kraus, and P. L. Tyack, 2005. The gunshot sound produced by male North Atlantic right whales (*Eubalaena glacialis*) and its potential function in reproductive advertisement. *Marine Mammal Science*, Vol 21, No 3, pp 458–475.

Parnell, J. F., R. M. Erwin, and K. C. Molina, 1995. Gull-billed Tern (*Sterna nilotica*), . in *The Birds of North America, No. 140*, A. Poole and F. Gill, eds. The Academy of Natural Sciences, Philadelphia and The American Ornithologists' Union, Washington, D.C.

Patriot Renewables, LLC, 2006. Fast Facts About the Proposed South Coast Offshore Wind Project. Retrieved from http://www.southcoastwind.org/fast-facts.html, on 10 May 2007.

Patteson, J. B., and E.S. Brinkley, 2004. A Petrel Primer: The Gadflies of North Carolina. *Birding*, Vol 36, No 6, pp 586–596. December.

Pavan, G., T. J. Hayward, J. F. Borsani, M. Priano, M. Manghi, C. Fossati, and J. Gordon, 2000. Time patterns of sperm whale codas recorded in the Mediterranean Sea 1985–1996. *Journal of the Acoustical Society of America*, Vol 107, No 6, pp 3487–3495.

Payne, K., P. Tyack, and R. Payne, 1983. Progressive changes in the songs of humpback whales (*Megaptera novaeangliae*): A detailed analysis of two seasons in Hawaii, in *Communication and Behavior of Whales, Vol AAAS Selected Symposia Series 76*, Payne, R., ed.Westview Press: Boulder, Colorado. pp 9–57.

Payne, P. M., and D.W. Heinemann, 1993. The distribution of pilot whales (*Globicephala* spp.) in shelf/shelf-edge and slope waters of the Northeastern United States, 1978–1988. *Reports of the International Whaling Commission*, Special Issue Vol 14, pp 51–68.

Payne, P. M. and L. A. Selzer, 1989. The distribution, abundance and selected prey of the harbor seal, *Phoca vitulina concolor*, in southern New England. *Marine Mammal Science*, Vol 5, No 2, pp 173–192.

Payne, P. M., and D. C. Schneider, 1984. Yearly changes in abundance of harbor seals, *Phoca vitulina*, at a winter haul-out site in Massachusetts. *Fishery Bulletin*, Vol 82, No 440–442.

Payne, P. M., D. N. Wiley, S. B. Young, S. Pittman, P. J. Clapham, and J. W. Jossi, 1990a. Recent fluctuations in the abundance of baleen whales in the southern Gulf of Maine in relation to changes in selected prey. *Fishery Bulletin*, Vol 88, pp 687–696.

Payne, P. M., D. W. Heinemann, and L. A. Selzer, 1990b. *A distributional assessment of cetaceans in shelf/shelf-edge and adjacent slope waters of the northeastern United States based on aerial and shipboard surveys, 1978–1988*. Report to the National Marine Fisheries Service, Northeast Fisheries Science Center, Woods Hole, Massachusetts. pp 108.

Payne, P. M., J. R. Nicolas, L. O'Brien, and K. D. Powers, 1986. The distribution of the humpback whale, *Megaptera novaeangliae*, on Georges Bank and in the Gulf of Maine in relation to densities of the sand eel, *Ammodytes americanus*. *Fishery Bulletin*, Vol 84, pp 271–277.

Payne, P. M., L. A. Selzer, and A. R. Knowlton, 1984. *Distribution and density of cetaceans, marine turtles, and seabirds in the shelf waters of the northeastern United States, June 1980 - December 1983, based on shipboard observations*. Contract number NA-81-FA-C-00023. Woods Hole, Massachusetts: National Marine Fisheries Service.

Payne, R. S,. and S. McVay, 1971. Songs of humpback whales. *Science*, Vol 173, No 3997, pp 585–597.

Pearson, W. H., J. R. Skalski, and C. I. Malme, 1992. Effects of sounds from a geophysical survey device on behavior of captive rockfish (*Sebastes* spp). *Canadian Journal of Fisheries and Aquatic Sciences*, Vol 49, No 7, pp 1343–1356.

Pendleton, L. H., 2004. *Creating Underwater Value: The Economic Value of Artificial Reefs for Recreational Diving*. Prepared for the The San Diego Oceans Foundation.

Pernick, R., 2005. Current Innovation: Wave Energy. *Northwest Energy News and Analysis*. Commentary. Retrieved from http://www.nwcurrent.com/commentary/ronpernick/1303107.html, on 24 July 2007.

Perrin, W. F., and J. R. Geraci, 2002. “Stranding,” in Encyclopedia of Marine Mammals, edited by W. F. Perrin, B. Würsig, and J. G. M. Thewissen (Academic Press, San Diego), pp. 1192-1197.

Perrin, W. F., E. D. Mitchell, J. G. Mead, D. K. Caldwell, and P. J. H. van Bree, 1981. Stenella clymene, a rediscovered tropical dolphin of the Atlantic. *Journal of Mammalogy*, Vol 62, No 3, pp 583–598.

Perrin, W. F., and A. A. Hohn, 1994. Pantropical spotted dolphin – *Stenella attenuate*, in *Handbook of Marine Mammals, Vol 5: The First Book of Dolphins*, S. H. Ridgway, and R. Harrison, eds. Academic Press: San Diego, California. pp 71–98.

Perrin, W. F., and J. G. Mead, 1994. Clymene dolphin - *Stenella clymene* (Gray, 1846), in *Handbook of Marine Mammals, Vol 5: The First Book of Dolphins,* Ridgway, S.H. and R. Harrison, eds.Academic Press: San Diego, California. pp 161–171.

Perrin, W. F., and J. W. Gilpatrick, Jr., 1994. Spinner dolphin - *Stenella longirostris* (Gray, 1828) in *Handbook of Marine Mammals, Vol 5: The First Book of Dolphins*, S. H. Ridgway and R. Harrison, eds. Academic Press: San Diego, California. pp 99–128.

Perrin, W. F. and R. L. Brownell, Jr., 2002. Minke whales *Balaenoptera acutorostrata* and *B. bonaerensis*, in *Encyclopedia of Marine Mammals*, W.F. Perrin,, B. Würsig, and J.G.M. Thewissen, eds. Academic Press: San Diego, California. pp 750–754.

Perrin, W. F. and W. A. Walker, 1975. The rough-toothed porpoise, *Steno bredanensis*, in the eastern tropical Pacific. *Journal of Mammalogy*, Vol 56, No 4, pp 905–907.

Perrin, W. F., 1998. *Stenella longirostris*. *Mammalian Species*, Vol 599, pp 1–7.

Perrin, W. F., 2002a. *Stenella frontalis*. *Mammalian Species*, Vol 702, pp 1–6.

Perrin, W. F., 2002b. Common dolphins *Delphinus delphis, D. capensis,* and *D. tropicalis*, in *Encyclopedia of Marine Mammals*, W.F. Perrin, B. Würsig, and J.G.M. Thewissen, eds. Academic Press: San Diego, California. pp 245–248.

Perrin, W. F., C. E. Wilson, and F. I. Archer II, 1994a. Striped dolphin, *Stenella coeruleoalba* (Meyen, 1833), in *Handbook of Marine Mammals, Vol 5: The First Book of Dolphins*, S. H. Ridgway and R. Harrison, eds. Academic Press: San Diego, California. pp 129–159.

Perrin, W. F., D. K. Caldwell, and M.C. Caldwell, 1994b. Atlantic spotted dolphin - *Stenella frontalis* (G. Cuvier, 1829), in *Handbook of Marine Mammals, Vol 5: The First Book of Dolphins*, S. H. Ridgway and R. Harrison, eds. Academic Press: San Diego, California. pp 173–190.

Perrin, W. F., E. D. Mitchell, J. G. Mead, D. K. Caldwell, and P. J. H. van Bree, 1981. *Stenella clymene*, a rediscovered tropical dolphin of the Atlantic. *Journal of Mammalogy*, Vol 62, No 3, pp 583–598.

Perrin, W. F., E. D. Mitchell, J. G. Mead, D. K. Caldwell, M. C. Caldwell, P. J. H. van Bree, and W. H. Dawbin, 1987. Revision of the spotted dolphins, *Stenella* spp. *Marine Mammal Science*, Vol 3, No 2, pp 99–170.

Perrin, W. F., M. L. L. Dolar, and D. Robineau, 1999. Spinner dolphins (*Stenella longirostris*) of the western Pacific and southeast Asia: Pelagic and shallow-water forms. *Marine Mammal Science*, Vol 15, No 4, pp 1029–1053.

Perrin, W. F., S. Leatherwood, and A. Collett, 1994c. Fraser's dolphin-*Lagenodelphis hosei* (Fraser, 1956), in *Handbook of Marine Mammals, Vol 5: The First Book of Dolphins*, S. H. Ridgway and R. Harrison, eds. Academic Press: San Diego, California. pp 223–240.

Perry, S. L., D. P. DeMaster, and G. K. Silber, 1999. The great whales: History and status of six species listed as endangered under the U.S. Endangered Species Act of 1973. *Marine Fisheries Review*, Vol 61, No 1, pp 1–74.

Perryman, W. L., D. W. K. Au, S. Leatherwood, and T. A. Jefferson, 1994. Melon-headed whale--*Peponocephala electra* (Gray, 1846), in *Handbook of Marine Mammals, Vol 5: The First Book of Dolphins*, S. H. Ridgway and R. Harrison, eds.Academic Press: San Diego, California. pp 363–386.

Petzet, G. A., 1999. Seismic, other sound at issue in deepwater Gulf of Mexico. *Oil and Gas Journal*, 13 September 1999.

Philips, J. D., P. E. Nachtigall, W. W. L. Au, J. L. Pawloski, and H. L. Roitblat, 2003. Echolocation in the Risso's dolphin, *Grampus griseus. Journal of the Acoustical Society of America*, Vol 113, No 1, pp 605–616.

Phillips, R., C. Niezrecki, and D.O. Beusse, 2004. Determination of West Indian manatee vocalization levels and rate. *Journal of the Acoustical Society of America*,, Vol 115, No 1, pp 422–428.

Piantadosi, C. A., and E. D. Thalmann, 2004. Whales, sonar, and decompression sickness. *Nature*. 15 April 2004.

Pitchford, T., 2006. Personal communication via e-mail between Mr. Tom Pitchford, Florida Marine Research Institute, St. Petersburg, Florida, and Ms. Dagmar Fertl, Geo-Marine, Inc., Plano, Texas, 28 August.

Plön, S., and R. Bernard, 1999. The fast lane revisited: Life history strategies of *Kogia* from southern Africa. Page 149 in *Abstracts, Thirteenth Biennial Conference on the Biology of Marine Mammals*. 28 November-3 December 1999. Wailea, Hawaii.

Plön, S., 2004. The status and natural history of pygmy (*Kogia breviceps*) and dwarf (*K. sima*) sperm whales off southern Africa. Ph.D. dissertation, Rhodes University.

Plön, S. E. E., R. W. Harris, P. M. Illgner, and V. G. C. Cockcroft, 1998. Analysis of pygmy (*Kogia breviceps*) and dwarf (*Kogia simus*) sperm whale strandings along the South African coastline using a geographic information system, in *Abstracts The World Marine Mammal Science Conference*. 20-24 January 1998. Monte Carlo, Monaco. p 108.

Plotkin, P. T., ed., 1995. *National Marine Fisheries Service and U.S. Fish and Wildlife Service status reviews for sea turtles listed under the Endangered Species Act of 1973.* National Marine Fisheries Service: Silver Spring, Maryland.

Podesta, M., A. D'Amico, G. Pavan, A. Drouga, A. Komnenou,and N. Portunato, 2006. A review of *Ziphius cavirostris* strandings in the Mediterranean Sea. *Journal of Cetacean Research and Mangagement*, Vol 7, No 3, pp 251–261.

Polacheck, T., 1995. The effect of increasing observer trackline effort in shipboard line transect surveys for harbor porpoise. *Reports of the International Whaling Commission*, Special Issue 16, pp 69–88.

Popov, V. V., and V. O. Klishin, 1998. EEG study of hearing in the common dolphin, *Delphinus delphis*. *Aquatic Mammals*, Vol 24, No 1, pp 13–20.

Popper, A. N., 1981. Comparative scanning electron microscopic investigations of the sensory epithelia in the teleost sacculus and lagena. *Journal of Comparative Neurology*, Vol 200, pp 357–374.

Popper, A. N., 2003. Effects of anthropogenic sounds on fishes. *Fisheries*, Vol 28, No 10, pp 24–31.

Popper, A. N., 2008. *Effects of Mid- and High-Frequency Sonars on Fish*. Naval Undersea Warfare Center Division, Newport, Rhode Island. Contract N66604-07M-6056. 21 February 2008.

Popper, A. N., A. Kane, D. L. Miller, M. E. Smith, J. Song, P. Stein, and L. E. Wysocki. 2007. The effects of high-intensity, low-frequency active sonar on rainbow trout. *Journal of the Acoustical Society of America*, 122 (1), pp 623-635.

Popper, A. N., and T. J. Carlson, 1998. Application of sound and other stimuli to control fish behavior. *Transactions of the American Fisheries Society*, Vol 127, pp 673–707.

Popper, A. N., and W. N. Tavolga, 1981. Structure and function of the ear in the marine catfish, *Arius felis*. *Journal of Comparative Physiology*, Vol 144, pp 27–34.

Poulakis, G. R., and J. C. Seitz, 2004. Recent occurrence of the smalltooth sawfish, *Pristis pectinata* (Elasmobranchiomorphi: Pristidae), in Florida Bay and the Florida Keys, with comments on sawfish ecology. *Florida Scientist*, Vol 67, pp 27–35.

Prescott, R., 2000. Sea turtles in New England waters. Conservation Perspectives. Accessed 14 October 2003. http://www.massscb.org/epublications/october2000/seaturtle.html.

Professional Association of Diving Instructors (PADI), 2006. *Open Water Diver Manual*. Diving Science and Technology for PADI: Rancho Santa Margarita, California.

Qadir, S. M. A., M. E. Fauth, D. J. Elstsodt, T. C. Arnold-Bemios, and A. Nave, 1994. *Otto Fuel II Environmental Survey*, IHSP 94-371, U.S. Department of the Navy, Naval Surface Warfare Center, Indian Head Division, Indian Head, Maryland, p 72.

Quaranta, A., P. Portalatini, and D. Henderson, 1998. Temporary and permanent threshold shift: An overview. *Scandinavian Audiology*, Vol 27, pp 75–86.

Quoddy Bay LNG, LLC, 2007. Quoddy Bay LNG. Retrieved from http://www.quoddylng.com/index.html on 17 Oct 2007.

Ramcharitar J., and A. N. Popper, 2004. Masked auditory thresholds in sciaenid fishes: A comparative study. *Journal of the Acoustical Society of America*, Vol 116, No 3, pp 1687–1691.

Ramcharitar, J. U., D. M. Higgs, and A. N. Popper, 2006b. Audition in sciaenid fishes with different swim bladder-inner ear configurations. *Journal of the Acoustical Society of America*, Vol 119, No 1, pp 439–443.

Ramcharitar, J., D. Gannon, A. Popper, 2006a. Bioacoustics of fishes of the family Sciaenidae (croakers and drums). *Transactions of the American Fisheries Society*, Vol 135, pp 1409–1431.

Ramcharitar, J., D. M. Higgs, and A. N. Popper, 2001. Sciaenid inner ears: a study in diversity. *Brain, Behavior, and Evolution*, Vol 58, pp 152–162.

Rankin, S. and J. Barlow, 2005. Source of the North Pacific "boing" sound attributed to minke whales. *Journal of the Acoustical Society of America*, Vol 118, No 5, pp 3346-3351.

Rankin, S. and J. Barlow, 2007. Vocalizations of the sei whale *Balaenoptera borealis* off the Hawaiian Islands. *Bioacoustics*, Vol 16, pp 137–145.

Rankin, S., D. Ljungblad, C. Clark, and H. Kato, 2005. Vocalisations of Antarctic blue whales, *Balaenoptera musculus intermedia*, recorded during the 2001/2002 and 2002/2003 IWC/SOWER circumpolar cruises, Area V, Antarctica. *Journal of Cetacean Research and Management*, Vol 7, No 1, pp 13-20.

Rankin-Baransky, K., 1997. *Origin of loggerhead turtles (*Caretta caretta*) in the western North Atlantic Ocean as determined by mtDNA analysis*. Master's thesis, Drexel University.

Rasmussen, M. H., L. A. Miller, and W. W .L. Au, 2002. Source levels of clicks from free-ranging white-beaked dolphins (*Lagenorhynchus albirostris* Gray 1846) recorded in Icelandic waters. *Journal of the Acoustical Society of America*, Vol 111, pp 1122–1125.

Rasmussen, M. H., M. Lammers, K. Beedholm, and L. A. Miller, 2006. Source levels and harmonic content of whistles in white-beaked dolphins (*Lagenorhynchus albirostris*). *Journal of the Acoustical Society of America*, Vol 120, No 1 pp 510–517. July 2006.

Read, A. J., and A. J. Westgate, 1997. Monitoring the movements of harbour porpoises (*Phocoena phocoena*) with satellite telemetry. *Marine Biology*, Vol 130, pp 315–322.

Read, A. J., 1990a. Reproductive seasonality in harbour porpoises, *Phocoena phocoena*, from the Bay of Fundy. *Canadian Journal of Zoology*, Vol 68, pp 284–288.

Read, A. J., 1990b. Age at sexual maturity and pregnancy rates of harbour porpoises *Phocoena phocoena* from the Bay of Fundy. *Canadian Journal of Fisheries and Aquatic Sciences*, Vol 47, pp 561–565.

Read, A. J., 1999. Harbour porpoise *Phocoena phocoena* (Linnaeus, 1758), in *Handbook of Marine Mammals, Vol 6: The Second Book of Dolphins and the Porpoises*, S. H. Ridgway and R. Harrison, eds. Academic Press: San Diego, California. pp 323–355.

Read, A. J., D. M. Waples, K.W. Urian, and D. Swanner, 2003b. Fine-scale behaviour of bottlenose dolphins around gillnets. *The Royal Society of London Biology Letters*, Suppl., Vol 270, pp S90–S92.

Read, A. J., J. R. Nicolas, and J. E. Craddock, 1996. Winter capture of a harbor porpoise in a pelagic drift net off North Carolina. *Fishery Bulletin*, Vol 94, pp 381–383.

Read, A. J., K. W. Urian, B. Wilson, and D. M. Waples, 2003a. Abundance of bottlenose dolphins in the bays, sounds, and estuaries of North Carolina. *Marine Mammal Science*, Vol 19, No 1, pp 59–73.

Read, A. J., P. Drinker, and S. Northridge, 2006. Bycatch of marine mammals in U.S. and global fisheries, *Conservation Biology*, Vol 20, pp 163–169.

Reeder, D. M., and K. M. Kramer, 2005. Stress in free-range mammals: Integrating physiology, ecology, and natural history, *Journal of Mammalogy*, Vol 86, No 2, pp 225–235.

Reeves, R. R., and E. Mitchell, 1986. American pelagic whaling for right whales in the North Atlantic. *Reports of the International Whaling Commission*, Special Issue 10, pp 221–254.

Reeves, R. R., and J. K. Ling, 1981. Hooded seal, *Cystophora cristata* Erxleben, 1777, in *Handbook of Marine Mammals, Vol 2: Seals*, S. H. Ridgway and R. J. Harrison, eds.Academic Press: London, England pp 171–203.

Reeves, R. R., and R. D. Kenney, 2003. Baleen whales: Right whales and allies, in *Wild Mammals of North America: Biology, Management, and Conservation, 2nd edition*, G. A. Feldhamer, B. C. Thompson, and J. A. Chapman, eds. Johns Hopkins University Press: Baltimore, Maryland. pp 425–463.

Reeves, R. R., 1990. An overview of the distribution, exploitation and conservation status of belugas, worldwide, in *For the future of the beluga: Proceedings of the International Forum for the Future of the Beluga*, J. Prescott and M. Gauquelin, eds.University of Quebec Press: Sillery. pp 47–58.

Reeves, R. R., and S. K. Katona, 1980. Extralimital records of white whales (*Delphinapterus leucas*) in eastern North American waters. *Canadian Field-Naturalist*, Vol 94, pp 239–247.

Reeves, R. R., B. S. Stewart, P. J. Clapham, and J. A. Powell, 2002b. *National Audubon Society guide to marine mammals of the world*. Alfred A. Knopf, Inc.: New York.

Reeves, R. R., C. Smeenk, C. C. Kinze, R. L. Brownell, Jr., and J. Lien, 1999b. White-beaked dolphin *Lagenorhynchus albirostris* Gray, 1846, in *Handbook of Marine Mammals, Vo 6: The Second Book of Dolphins and the Porpoises*, S. H. Ridgway and R. Harrison, eds. Academic Press: San Diego. pp 1–30.

Reeves, R. R., J. M. Breiwick, and E. D. Mitchell, 1999a. History of whaling and estimated kill of right whales, *Balaena glacialis*, in the northeastern United States, 1620-1924. *Marine Fisheries Review*, Vol 61, No 3, pp 1–36.

Reeves, R. R., R. Rolland, and P. J. Clapham, 2001. C*auses of reproductive failure in North Atlantic right whales: New avenues of research*. Report of a workshop held 26-28 April 2000, Falmouth, Massachusetts. Northeast Fisheries Science Center Reference Document 01-16. Woods Hole, Massachusetts: National Marine Fisheries Service.

Reeves, R. R., S. Leatherwood, G.S. Stone, and L.G. Eldredge, 1999c. *Marine mammals in the area served by the South Pacific Regional Environment Programme (SPREP)*. Apia, Samoa: South Pacific Regional Environment Programme.

Reeves, R. R., T. D. Smith, and E. A. Josephson, 2007. Near-annihilation of a species: Right whaling in the North Atlantic, in The Urban Whale: North Atlantic Right Whales at the Crossroads, Kraus, S.D. and R.M. Rolland, eds.Harvard University Press: Cambridge, Massachusetts. pp 39–74.

Reeves, R. R., T. D. Smith, R. L. Webb, J. Robbins, and P.J. Clapham, 2002a. Humpback and fin whaling in the Gulf of Maine from 1800 to 1918. *Marine Fisheries Review*, Vol 64, No 1, pp 1–12.Reeves, R. R., W. F. Perrin, B. L. Taylor, C. S. Baker, and S. L. Mesnick, eds., 2004. *Report of the Workshop on Shortcomings of Cetacean Taxonomy in Relation to Needs of Conservation and Management, April 30 - May 2, 2004 La Jolla, California*. NOAA Technical Memorandum NMFS-SWFSC-363:1-94.

Reichart, H. A. 1993. *Synopsis of biological data on the olive ridley sea turtle* Lepidochelys olivacea *(Eschscholtz, 1829) in the western Atlantic*. NOAA Technical Memorandum NMFS-SEFSC-336:1-78.

Reid, A. J., 2000. Florida manatee now resident in the Bahamas. *SireNews*, Vol 33, p 6.

Reid, J. P., G. B. Rathbun, and J. R. Wilcox, 1991. Distribution patterns of individually identifiable West Indian manatees (*Trichechus manatus*) in Florida. *Marine Mammal Science*, Vol 7, No 2, pp 180–190.

Reijnders, P. J. H., and A. Aguilar, 2002. Pollution and marine mammals, in *Encyclopedia of Marine Mammals*, W. F. Perrin, B. Würsig, and J. G. M. Thewissen, eds. Academic Press: San Diego. pp 948–957.

Remage-Healey, L., D. P. Nowacek, and A. H. Bass, 2006. Dolphin foraging sounds suppress calling and elevate stress hormone levels in a prey species, the Gulf toadfish. *The Journal of Experimental Biology*, Vol 209, pp 4444–4451.

Renaud, M. L., and J. A. Carpenter, 1994. Movements and Submergence Patterns of Loggerhead Turtles (*Caretta caretta*) in the Gulf of Mexico Determined Through Satellite Telemetry. *Bulletin of Marine Science*, Vol 55, pp 1–15.

Renaud, M. L., 1995. Movements and Submergence Patterns of Kemp's Ridley Turtles (*Lepidochelys kempii*). *Journal of Herpetology* 29:370-374.

Renaud, M. L., and J. A. Williams. 2005. Kemp's ridley sea turtle movements and migrations. *Chelonian Conservation and Biology*, Vol 4, No 4, pp 808–816.

Renaud, M. L., J. A. Carpenter, J. A. Williams, and S. A. Manzella-Tirpak, 1995. Activities of juvenile green turtles, *Chelonia mydas*, at a jettied pass in south Texas. *Fishery Bulletin*, Vol 93, pp 586–593.

Rendell, L., and H. Whitehead, 2004. Do sperm whales share coda vocalizations? Insights into coda usage from acoustic size measurement. *Animal Behaviour*, Vol 67, pp 865–874.

Rendell, L. E., and J. C. D. Gordon, 1999. Vocal Response of Long-Finned Pilot Whales (*Globicephala melas*) to Military Sonar in the Ligurian Sea. *Marine Mammal Science*, Vol 15, No 1, pp 198–204.

Rester, J., and R. Condrey, 1996. The occurrence of the hawksbill turtle, *Eretmochelys imbricata*, along the Louisiana coast. *Gulf of Mexico Science*, Vol 2, pp 112–114.

Reynolds III, J. E. and J. C. Ferguson, 1984. Implications of the presence of manatees (*Trichechus manatus*) near the Dry Tortugas Islands. *Florida Scientist*, Vol 47, No 3, pp 187–189.

Reynolds III., J. E., 1981. Behavior patterns in the West Indian manatee with emphasis on feeding and diving. *Florida Scientist*, Vol 44, pp 233–242.

Rhinehart, H. L., C. A. Manire, J. D. Buck, P. Cunningham-Smith, and D. R. Smith, 1999. Observations and rehabilitation of rough-toothed dolphins, *Steno bredanensis*, treated at Mote Marine Laboratory from two separate stranding events, in *Abstracts*, *Thirteenth Biennial Conference on the Biology of Marine Mammals*. November 28 – December 3, 1999. Wailea, Maui. p 157.

Rice, D. W., 1989. Sperm whale--*Physeter macrocephalus* (Linnaeus, 1758). in *Handbook of Marine Mammals, Vol 4: River Dolphins and the Larger Toothed Whales*, S. H. Ridgway and R. Harrison, eds. Academic Press: San Diego, California. pp 177–234.

Rice, D. W., 1998. *Marine mammals of the world: Systematics and distribution*. Special Publication No. 4. Lawrence, Kansas: Society for Marine Mammalogy.

Richardson, D. T., 1975. Hooded seal whelps at South Brooksville, Maine. *Journal of Mammalogy*, Vol 56, No 3, pp 698–699.

Richardson, D. T., 1976. *Assessment of harbor and gray seal populations in Maine*. Final report to the Marine Mammal Commission, Contract Number MM4AC009. West Boothbay Harbor, Maine : Fisheries Research Station..

Richardson, W. J., B. Würsig, and C. R. Greene, Jr., 1986. Reactions of bowhead whales, *Balaena mysticetus*, to seismic exploration in the Canadian Beaufort Sea. *Journal of the Acoustical Society of America*, Vol 79, pp 1117–1128.

Richardson, W. J., B. Würsig, and C. R. Greene, Jr., 1990b. Reactions of bowhead whales, *Balaena mysticetes*, to drilling and dredging noise in the Canadian Beaufort Sea. *Marine Environmental Research*, Vol 29, pp 135–160.

Richardson, W. J., C. R. Greene Jr., C. I. Malme, and D. H. Thomson, 1995. *Marine Mammals and Noise*. Academic Press: San Diego, California.

Richardson, W. J., C. R. Greene Jr., W. R. Koski, C. I. Malme, G. W. Miller, M. A. Smultea, and B. Würsig, 1990a. *Acoustic effects of oil production activities on bowhead and white whales visible during spring migration near Pt. Barrow, Alaska – 1989 phase*. Report prepared by LGL Environmental Research Associates Ltd. for the U.S. Department of the Interior, Minerals Management Service, Anchorage, Alaska. NTIS PB91-105486/

Richardson, W. J., C. R. Greene Jr., W. R. Koski, M. A. Smultea, G. Cameron, C. Holdsworth, G. Miller, T. Woodley, and B. Würsig, 1991. *Acoustic effects of oil production activities on bowhead and white whales visible during spring migration near Pt. Barrow, Alaska – 1990 phase*. Report prepared by LGS Environmental Research Associates Ltd. for the U.S. Department of Interior, Minerals Management Service, Anchorage, Alaska. NTIS PB92-170430.

Richardson, W. J., 1995. Marine mammal hearing, in *Marine Mammals and Noise*, W. J. Richardson, C.R. Greene, Jr., C.I. Malme, and D.H. Thomson, eds. Academic Press: San Diego, California. pp 205–240.

Richer, S., 2003. Nova Scotians awake to find a rare walrus in their midst. Retreived from http://www.fisheries.ubc.ca/publications/news/Globe_And_Mail_12_Jun_2003.pdf, on 6 October 2004.

Ridgway, S. H., and D.A. Carder, 2001. Assessing hearing and sound production in cetaceans not available for behavioral audiograms: Experiences with sperm, pygmy sperm, and gray whales. *Aquatic Mammals*, Vol 27, No 3, pp 267–276.

Ridgway, S. H., 1986. Diving by cetaceans, in *Diving in Animals and Man*, A.O. Brubakk, J.W. Kanwisher, and G. Sundness, eds. The Royal Norwegian Society of Science and Letters: Trondheim, Norway. pp 33–62.

Ridgway, S. H., 2000. The auditory central nervous system, in *Hearing by Whales and Dolphins*, W.W.L. Au, A.N. Popper, and R.R. Fay, eds.Springer-Verlag: New York. pp 273–293.

Ridgway, S. H., and R. Howard, 1979. Dolphin lung collapse and intramuscular circulation during free diving: evidence from nitrogen washout. *Science*, Vol 206, pp 1182–1183.

Ridgway, S. H. and P. L. Joyce, 1975. Studies on seal brain by radiotelemetry. *Rapports et Proces-Verbaux des Reunions Conseil International pour l'Exploration de la Mer*, Vol 169, pp 81–91.

Ridgway, S. H., B. L. Scronce, and J. Kanwisher, 1969a. Respiration and deep diving in the bottlenose porpoise. *Science*, Vol 166, pp 1651–1654.

Ridgway, S. H., D. A. Carder, R. R. Smith, T. Kamolnick, C. E. Schlundt, and W. R. Elsberry, 1997. *Behavioral responses and temporary shift in masked hearing threshold of bottlenose dolphins, Tursiops truncatus, to 1-second tones of 141 to 201 dB re 1 μPa*. Technical Report 1751, Revision 1. San Diego, California: Naval Sea Systems Command.

Ridgway, S. H., D. A. Carder, T. Kamolnick, R. R. Smith, C. E. Schlundt, and W. R. Elsberry, 2001. Hearing and whistling in the deep sea: Depth influences whistle spectra but does not attenuate hearing by white whales (*Delphinapterus leucas*). *Journal of Experimental Biology*, Vol 204, pp 3829–3841.

Ridgway, S. H., E. G. Wever, J. G. McCormick, J. Palin, and J. H. Anderson, 1969b. Hearing in the giant sea turtle, *Chelonia mydas*. *Proceedings of the National Academy of Sciences*, Vol 64, pp 884–890.

Ridoux, V., A. J. Hall, G. Steingrimsson, and G. Olaffson, 1998. An inadvertent homing experiment with a young ringed seal, *Phoca hispida*. *Marine Mammal Science*, Vol 14, No 4, pp 883–888.

Rivers, J. A., 1997. Blue whale, *Balaenoptera musculus*, vocalizations from the waters off central California. *Marine Mammal Science*, Vol 13, No 2, pp 186–195.

Romano, T. A., M. J. Keogh, M. J.,C. Kelly, C.,P. Feng, P., C. E. Berk, C. E.,C. Schlundt, C.,D. Carder, D. and J. Finneran, J., 2004. Anthropogenic sound and marine mammal health: measures of the nervous and immune systems before and after intense sound exposure. Canadian *Journal of Fisheries and Aquatic Science*, Vol 61, pp 1124–1134.

Ronald, K., and J. L. Dougan, 1982. The ice lover: Biology of the harp seal (*Phoca groenlandica*). *Science*, Vol 215, pp 928–933.

Ronald, K., and P. J. Healey, 1981. Harp seal, *Phoca groenlandica* Erxleben, 1777, in *Handbook of Marine Mammals, Vol 2: Seals*, S. H. Ridgway and R. J. Harrison, eds.Academic Press: London, England. pp 55–87.

Rosel, P. E., A. E. Dizon, and J. E. Heyning, 1994. Genetic analysis of sympatric morphotypes of common dolphins genus *Delphinus*. *Marine Biology*, Vol 119, pp 159–167.

Rosel, P. E., J. Y. Wang, and J. J. Pella, 1999b. Seasonal changes in northwest Atlantic harbor porpoise populations: Summer isolation and winter mixing, in *Abstracts, Thirteenth Biennial Conference on the Biology of Marine Mammals*. 28 November-3 December 1999. Wailea, Maui. pp 162–163.

Rosel, P. E., R. Tiedemann, and M. Walton, 1999a. Genetic evidence for limited trans-Atlantic movements of the harbor porpoise *Phocoena phocoena*. *Marine Biology*, Vol 133, pp 583–591.

Rosenbaum, H. C., R. L. Brownell, M. W. Brown, C. Schaeff, V. Portway, B. N. Whiate, S. Malik, L. A. Pastene, N. J. Patenaude, C. S. Baker, M. Goto, P. B. Best, P. J. Clapham, P. Hamilton, M. Moore, R. Payne, V. Rowntree, C. T. Tynan, J. L. Bannister, and R. DeSalle, 2000. World-wide genetic differentiation of *Eubalaena*: Questioning the number of right whale species. *Molecular Ecology*, Vol 9, No 1, pp 1793–1802.

Rosenfeld, M., M. George, and J. M. Terhune, 1988. Evidence of autumnal Harbour Seal, *Phoca vitulina*, movement from Canada to the United States. *Canadian Field-Naturalist*, Vol 102, No 3, pp 527–529.

Ross, G. J. B., and S. Leatherwood, 1994. Pygmy killer whale, *Feresa attenuata* Gray, 1874, in *Handbook of Marine Mammals, Vol 5: The First Book of Dolphins*, S. H. Ridgway and R. Harrison, eds. Academic Press: San Diego, California. pp 387–404.

Ross, Q. E., D. J. Dunning, J. K. Menezes, M. J. Kenna, Jr., and G. Tiller, 1996. Reducing impingement of alewives with high frequency sound at a power plant on Lake Ontario. *North American Journal of Fisheries Management*, Vol 16, pp 548–559.

Ross, S. T., R. J. Heise, J. A. Ewing, III, M. F. Cashner, and W. T. Slack, 2002. *Movement and habitat use of Gulf sturgeon (*Acipenser oxyrinchus desotoi*) in Mississippi coastal waters.* MASGP-00-017. Mississippi-Alabama Sea Grant Consortium.

Rough, V., 1995. *Gray seals in Nantucket Sound, Massachusetts: Winter and spring, 1994*. Final report to the U.S. Marine Mammal Commission. Springfield, Virginia: National Technical Information Service.

Rowlett, R. A., 1980. Observations of marine birds and mammals in the northern Chesapeake Bight. FWS/OBS-80/04. Washington, D.C.: U.S. Fish and Wildlife Service.

Rubinstein, B. L., 1994. *An apparent shift in distribution of ice seals,* Phoca groenlandica, Cystophora cristata, *and* Phoca hispida, *toward the east coast of the United States*. M.A. in Biology, Boston Univeristy.

Rudloe, A., J. Rudloe and J. Ogren, 1991. Occurence of immature Kemp's ridley turtles, *Lepidochelys kempi*, in coastal waters of northwest Florida. *Northwest Gulf Science*, Vol 12, pp 49–53.

Ruppert, E., and R. D. Barnes, 1994. *Invertebrate Zoology*. Saunders College Publishing, a division of Harcourt Brace College Publishers: New York.

Sadove, S. S., P. Forestell, and H. Knappe, 1999. Increasing presence of Arctic seal species in the New York Bight as evidenced in aerial surveys and stranding records, in *Abstracts, Thirteenth Biennial Conference on the Biology of Marine Mammals*. 28 November-3 December 1999. Wailea, Maui. p 164.

Safe Harbor Energy, 2007. Safe Harbor Energy – A project of the Atlantic Sea Island Group. LLC. Retrieved from http://www.atlanticseaislandgroup.com/project_overview.shtml, on 17 October 2007.

Sakamoto, W., I. Uchida, Y. Naito, K. Kureha, M. Tujimura, and K. Sato, 1990. Deep Diving Behavior of the Loggerhead Turtle Near the Frontal Zone. *Nippon Suisan Gakkaishi*, Vol 56, pp 1435–1443.

Salden, D. R., 1989. An observation of apparent feeding by a sub-adult humpback whale off Maui, Hawaii, in *Abstracts, Eighth Biennial Conference on the Biology of Marine Mammals*. 7-11 December 1989. Pacific Grove, California. p 58.

Sanders, I. M., J. C. Barrios-Santiago, and R. S. Appeldoorn, 2005. Distribution and relative abundance of humpback whales off western Puerto Rico during 1995–1997. *Caribbean Journal of Science*, Vol 41, No 1, pp 101–107.

Santos, M. B., G. J. Pierce, A. López, R. J. Reid, V. Ridoux, and E. Mente, 2006. Pygmy sperm whales *Kogia breviceps* in the Northeast Atlantic: New information on stomach contents and strandings. *Marine Mammal Science*, Vol 22, No 3, pp 600–616.

Santos, M. B., G. J. Pierce, J. Herman, A. López, A. Guerra, E. Mente, and M. R. Clarke, 2001. Feeding ecology of Cuvier's beaked whale (*Ziphius cavirostris*): A review with new information on the diet of this species. *Journal of the Marine Biological Association of the United Kingdom*, Vol 81, pp 687–694.

Sardi, K. A., M. T. Weinrich, and R. C. Connor, 2005. Social interactions of humpback whale (*Megaptera novaeangliae*) mother/calf pairs on a North Atlantic feeding ground. *Behaviour*, Vol 142, pp 731–750.

Sasaki, T., M. Nikaido, S. Wada, T. K. Yamada, Y. Cao, M. Hasegawa, and N. Okada, 2006. *Balaenoptera omurai* is a newly discovered baleen whale that represents an ancient evolutionary lineage. *Molecular Phylogentics and Evolution*, Vol 41, pp 40–52.

Saulitis, E. L., C. O. Matkin, and F. H. Fay, 2005. Vocal repertoire and acoustic behavior of the isolated AT1 killer whale subpopulation in southern Alaska. *Canadian Journal of Zoology*, Vol 83, pp 1015–1029.

Saunders, J. C., J. H. Mills, and J. D. Miller, 1977. Threshold shift in the chinchilla from daily exposure to noise for six hours. *Journal of the Acoustical Society of America*, Vol 61, pp 558–570.

Schaeff, C. M., S. D. Kraus, M. W. Brown, and B. N. White, 1993. Assessment of the population structure of the western North Atlantic right whale (*Eubalaena glacialis*) based on sighting and mtDNA. *Canadian Journal of Zoology*, Vol 71, pp 339–345.

Schevill, W. E., W. A. Watkins, and C. Ray, 1963. Underwater sounds of pinnipeds. *Science*, Vol 141, pp 50–53.

Schilling, M. R., I. Seipt, M. T. Weinrich, S. E. Frohock, A. E. Kuhlberg, and P. J. Clapham, 1992. Behavior of individually-identified sei whales *Balaenoptera borealis* during an episodic influx into the southern Gulf of Maine in 1986. *Fishery Bulletin*, Vol 90, pp 749–755.

Schlundt, C. E., J. J. Finneran, D. A. Carder, and S. H. Ridgway, 2000. Temporary threshold shift in masked hearing thresholds of bottlenose dolphins, *Tursiops truncatus*, and white whales, *Delphinapterus leucas*, after exposure to intense tones. *Journal of the Acoustical Society of America*, Vol 107, pp 3496–3508.

Schlundt, C. E., R. L. Dear, D. A. Carder, and J. J. Finneran. 2006. Growth and recovery of temporary threshold shifts in a dolphin exposed to mid-frequency tones with durations up to 128 s. *Journal of the Acoustical Society of America*, Vol 120, No 5, pp 3227A.

Schmid, J.R., A.B. Bolten, K.A. Bjorndal, and W.J. Lindberg. 2002. Activity patterns of Kemp's ridley turtles, *Lepidochelys kempii*, in the coastal waters of the Cedar Keys, Florida. *Marine Biology*, Vol 140, pp 215-228.

Schmid, J. R., and W. J. Barichivich, 2005. Developmental biology and ecology of the Kemp's ridley sea turtle, *Lepidochelys kempii*, in the eastern Gulf of Mexico. *Chelonian Conservation and Biology*, Vol 4, No 4, pp 828–834.

Schmidly, D. J., 1981. *Marine mammals of the southeastern United States coast and the Gulf of Mexico*. FWS/OBS-80/41. Washington, D.C.: U.S. Fish and Wildlife Service.

Schmidly, D. J., C. O. Martin, and G. F. Collins, 1972. First occurrence of a black right whale (*Balaena glacialis*) along the Texas coast. *Southwestern Naturalist*, Vol 17, No 2, pp 214–215.

Schneider, D. C. and P. M. Payne, 1983. Factors affecting haul-out of harbor seals at a site in southeastern Massachusetts. *Journal of Mammalogy*, Vol 64, No 3, pp 518–520.

Schoenherr, J. R., 1991. Blue whales feeding on high concentrations of euphausiids around Monterey Submarine Canyon. *Canadian Journal of Zoology*, Vol 69, pp 583–594.

Scholik, A. R., and H. Y. Yan, 2001. Effects of underwater noise on auditory sensitivity of a cyprinid fish. *Hearing Research*, Vol 152, pp 17–24.

Scholik, A. R., and H. Y. Yan, 2002. Effects of boat engine noise on the auditory sensitivity of the fathead minnow, *Pimephales promelas*. *Environmental Biology of Fishes*, Vol 63, pp 203–209.

Schotten, M., W. W. L. Au, M. O. Lammers, and R. Aubauer, 2004. Echolocation recordings and localization of wild spinner dolphins (*Stenella longirostris*) and pantropical spotted dolphins (S. *attenuata*) using a four-hydrophone array, in *Echolocation in bats and dolphins*, J. A. Thomas, C.F. Moss, and M. Vater, eds.University of Chicago Press: Chicago, Illinois. pp 393–400.

Schreiber, E. A., C. J. Feare, B. A. Harrington, B. G. Murray, Jr., W. B. Robertson, Jr., M. J. Robertson, and G. E. Woolfenden, 2002. Sooty Tern (*Sterna fuscata*), in *The Birds of North America, No. 665*, A. Poole and F. Gill, eds. The Birds of North America, Inc: Philadelphia, PA.

Schroeder, B. A., and N. B. Thompson. 1987. Distribution of the loggerhead turtle, *Caretta caretta*, and the leatherback turtle, *Dermochelys coriacea*, in the Cape Canaveral, Florida area: results of aerial surveys, *Ecology of East Florida Sea Turtles*, W. N. Witzell, ed. NOAA Technical Report NMFS 53. National Marine Fisheries Service; Miami, Florida. pp 45–53.

Schroeder, C., 2000. *Population status and distribution of the harbor seal in Rhode Island waters*. Master's thesis, University of Rhode Island, Graduate School of Oceanography.

Schroeder, C., and R. Kenney, 2001. Harbor seals, *Phoca vitulina*, in Rhode Island, USA waters, in *Abstracts, Fourteenth Biennial Conference on the Biology of Marine Mammals*. 28 November–3 December 2001. Vancouver, British Columbia. p 191.

Schultz, K. W., D. H. Cato, P. J. Corkeron, and M. M. Bryden, 1995. Low frequency narrow-band sounds produced by bottlenose dolphins. *Marine Mammal Science*, Vol 11, No 4, pp 503–509.

Schultz, L. P., 2004. Smalltooth sawfish: the USA's first endangered elasmobranch? *Marine Matters*, Vol 19, pp 45–49.

Schusterman, R. J., R. F. Balliet, R. F., and J. Nixon, J., 1972. Underwater audiogram of the California sea lion by the conditioned vocalization technique. *Journal of the Experimental Analysis of Behavior*, Vol 17, 339–350.

Schusterman, R.J., D. Kastak, D.H. Levenson, C.J. Reichmuth, and B.L. Southall, 2000. Why pinnipeds don't echolocate. *Journal of the Acoustical Society of America*, Vol 107, pp 2256-2264.

Schwartz, F. J., 1989. Biology and ecology of sea turtles frequenting North Carolina, in *Proc. North Carolina Oceanography Symposium*, R. Y. George and A. W. Hulbut (eds.). NOAA-NURP Report 89-2. F. Schwartz, Inst. Marine Sci., Univ. North Carolina, 3407 Arendell St., Moorehead City, NC 28557 USA. pp 307-331.

Schwartz, F. J., 1995. Florida Manatees, *Trichechus manatus* (Sirenia: *Trichechidae*), in North Carolina 1919-1994. *Brimleyana*, Vol 22, No 53–60.

Schweder, T., and G. Høst. 1992. Integrating experimental data and survey data to estimate g(0): A first approach. *Reports of the International Whaling Commission*, Vol 42, pp 575–582.

Schweder, T., H. J. Skaug, X. K. Dimakos, M. Langaas, and N. Øien, 1997. Abundance of northeastern Atlantic minke whales, estimates for 1989 and 1995. *Reports of the International Whaling Commission*, Vol 47, No 4, pp 483.

Schweder, T., N. Øien, and G. Høst, 1991. Estimates of the detection probability for shipboard surveys of northeastern Atlantic minke whales, based on a parallel ship experiment. *Reports of the International Whaling Commission*, Vol 41, No 4, pp 432.

Schweder, T., N. Øien, and G. Høst, 1992. Estimates of g(0) for Northeastern Atlantic minke whales based on independent observer experiments in 1989 and 1990, found by the hazard probability method. *Reports of the International Whaling Commission*, Vol 42, No 3, pp 405.

Science and the Sea, 2007. Retrieved from http://www.scienceandthesea.org, on 2 July 2007.

Scott, M. D., and K. L. Cattanach, 1998. Diel patterns in aggregations of pelagic dolphins and tuna in the eastern Pacific. *Marine Mammal Science*, Vol 14, No 3, pp 401–428.

Scott, M. D., A. A. Hohn, A. J. Westgate, J. R. Nicolas, B. R. Whitaker, and W. B. Campbell, 2001. A note on the release and tracking of a rehabilitated pygmy sperm whale (*Kogia breviceps*). *Journal of Cetacean Research and Management*, Vol 3, No 1, pp 87–94.

Scott, T. M., and S. S. Sadove, 1997. Sperm whale, *Physeter macrocephalus*, sightings in the shallow shelf waters off Long Island, New York. *Marine Mammal Science*, Vol 13, No 2, pp 317–321.

Scowcroft, G., K. Vigness Raposa, C. Knowlton, and J. Johnen, 2006. *Discovery of Sound in the Sea*. University of Rhode Island.

Sea Turtle Restoration Project, 2007. Issue Briefings: Turtles and Shrimp Nets. Accessed at www.seaturtles.org/issue_briefings2.cfm?issueBriefID=1 on 8 June 2007.

Sears, C. J., B. W. Bowen, R.W. Chapman, S. B. Galloway, S. R. Hopkins-Murphy, and C. M. Woodley. 1995. Demographic composition of the feeding population of juvenile loggerhead sea turtles (*Caretta caretta*) off Charleston, South Carolina: Evidence from mitochondrial DNA markers. *Marine Biology*, Vol 123, pp 869–874.

Sears, R., C. L. K. Burton, and G. Vikingson, 2005. Review of blue whale (*Balaenoptera musculus*) photoidentification distribution data in the North Atlantic, including the first long-range match between Iceland and Mauritania, in *Abstracts, Sixteenth Biennial Conference on the Biology of Marine Mammals*. 12–16 December 2005. San Diego, California. p 254.

Sears, R., J. M. Williamson, F. W. Wenzel, M. Bérubé, D. Gendron, and P. Jones, 1990. Photographic identification of the blue whale (*Balaenoptera musculus*) in the Gulf of St. Lawrence, Canada. *Reports of the International Whaling Commission,* Special Issue 12, pp 335–342.

Seaworld, 2007. Infobooks. Bony Fish--Senses. Retrieved from http://www.seaworld.org/infobooks/BonyFish/ senses.html, on June 22, 2007.

Seitz, J. C., and G. R. Poulakis, 2002. Recent occurrence of sawfishes (Elasmobranchiomorphi: Pristidae) along the southwest coast of Florida (USA). *Florida Scientist*, Vol 65, pp 256–266.

Sellas, A. B., R. S. Wells, and P. E. Rosel, 2005. Mitochondrial and nuclear DNA analyses reveal fine scale geographic structure in bottlenose dolphins (*Tursiops truncatus*) in the Gulf of Mexico. *Conservation Genetics*, Vol 6, pp 715–728.

Selzer, L. A., and P. M. Payne, 1988. The distribution of white-sided (*Lagenorhynchus acutus*) and common dolphins (*Delphinus delphis*) versus environmental features of the continental shelf of the northeastern United States. *Marine Mammal Science,* Vol 4, No 2, pp 141–153.

Sergeant, D. E., 1963. Minke whales, *Balaenoptera acutorostrata* Lacépède, of the western North Atlantic. *Journal of the Fisheries Research Board of Canada,* Vol 20, No 6, pp 1489–1504.

Sergeant, D. E., D. J. St. Aubin, and J. R. Geraci, 1980. Life history and northwest Atlantic status of the Atlantic white-sided dolphin, *Lagenorhynchus acutus*. *Cetology*, Vol 37, pp 1–12.

Serrano, A., 2001. New underwater and aerial vocalizations of captive harp seals (*Pagophilus groenlandicus*). Canadian *Journal of Zoology,* Vol 79, pp 75–81.

Sevaldsen, E. M., and P. H. Kvadsheim, 2004. Active sonar and the marine environment, in *High Frequency Ocean Acoustics*, M. B. Porter, M. Siderius, and W. A. Kuperman, eds. Conference Proceedings 728, American Institute of Physics 0-7354-0210-8/04. pp 272–279.

Shane, S. H., 1990. Comparison of bottlenose dolphin behavior in Texas and Florida, with a critique of methods for studying dolphin behavior, in *The Bottlenose Dolphin*, S. Leatherwood and R. R. Reeves, eds. Academic Press: San Diego. pp 541–558.

Shane, S. H., 1994. Occurrence and habitat use of marine mammals at Santa Catalina Island, California from 1983–91. *Bulletin of the Southern California Academy of Sciences*, Vol 93, pp 13–29.

Shaver, D. J., B. A. Schroeder, R. A. Byles, P. M. Burchfield, J. Peña, R. Márquez, and H. J. Martinez. 2005. Movements and home ranges of adult male Kemp's ridley sea turtles (Lepidochelys kempii) in the Gulf of Mexico investigated by satellite telemetry. *Chelonian Conservation and Biology*, Vol 4, No 4, pp 817–827.

Shealer, D., 1999. Sandwich Tern (*Sterna sandvicensis*), in *The Birds of North America, No. 405*, A. Poole and F. Gill, eds. The Birds of North America, Inc.: Philadelphia, PA.

Sheavly, S. B., 2007. *National Marine Debris Monitoring Program: Final Program Report, Data Analysis and Summary*. Prepared for U.S. Environmental Protection Agency by Ocean Conservancy, Grant Number X83053401-02. 76 pp.

Shields, M., 2002. Brown Pelican (*Pelecanus occidentalis*), in *The Birds of North America*, No. 609, A. Poole and F. Gill, eds. The Birds of North America, Inc.: Philadelphia, PA.

Shoop, C. R., and T. J. Thompson, 1983. *Southeast Turtle Survey (SETS)*. Final report to the National Marine Fisheries Service. Pelagic surveys. Contract Number NA82-GA-C-00012 Prepared for the National Marine Fisheries Service, Southeast Fisheries Science Center, Miami, Florida by Aero-Marine Surveys Inc., Groton, Connecticut.

Shoop, C. R., and R. D. Kenney, 1992. Seasonal Distributions and Abundances of Loggerhead and Leatherback Sea Turtles in Waters of the Northeastern United States. *Herpetological Monographs*, Vol 6, pp 43–67.

Shoup, 2004a. Acoustic Modeling Results of the Haro Strait For 5 May 2003. Naval Research Laboratory Report, Office of Naval Research, 30 January 2004.

Shoup, 2004b. EEEL Analysis of Shoup Transmissions in the Haro Strait on 5 May 2003. Naval Research Laboratory briefing of 2 September 2004.

Shoup, 2004c. Report on the Results of the Inquiry into Allegations of Marine Mammal Impacts Surrounding the Use of Active Sonar by USS Shoup (DDG 86) in the Haro Strait on or about 5 May 2003. 9 February 2004.

Siciliano, S., M. C. O. Santos, A. F. C. Vicente, F. S. Alvarenga, E. Zampirolli, J.L. Brito, Jr., A. F. Azevedo, and J. L. A. Pizzorno, 2004. Strandings and feeding records of Bryde’s whales (*Balaenoptera edeni*) in south-eastern Brazil. *Journal of the Marine Biological Association of the United Kingdom*, Vol 84, pp 857–859.

Silber, G. K. and P. J. Clapham, 2001. *Draft updated recovery plan for the western North Atlantic right whale (*Eubalaena glacialis*)*. Silver Spring, Maryland: National Marine Fisheries Service.

Silber, G. K., 1986. The relationship of social vocalizations to surface behavior and aggression in the Hawaiian humpback whale (*Megaptera novaeangliae*). *Canadian Journal of Zoology*, Vol 64, pp 2075–2080.

Simão, S. M. and S. C. Moreira, 2005. Vocalizations of female humpback whale in Arraial do Cabo (RJ, Brazil). *Marine Mammal Science*, Vol 21, No 1, pp 150–153.

Simmonds, M. P. and L. F. Lopez-Jurado, 1991. Whales and the military. *Nature*, Vol 351, pp 448.

Simmonds, M., S. Dolman, and L. Weilgard (eds)., 2004. *Oceans of Noise 2004: A Whale and Dolphin Conservation Society Science Report*.

Simon, M., M. Wahlberg, and L. E. Miller, 2007. Echolocation clicks from killer whales (*Orcinus orca*) feeding on herring (*Clupea harengus*) (L). *Journal of the Acoustical Society of America*, Vol 121, No 2, pp 749–752.

Simpfendorfer, C. A., 2002. Smalltooth sawfish: the USA’s first endangered elasmobranch? *Marine Matters*, Vol 19, pp 45–49.

Simpfendorfer, C. A., and T. R. Wiley, 2005b. *Identification of priority areas for smalltooth sawfish conservation*. Mote Marine Laboratory Technical Report.

Simpfendorfer, C. A., and Wiley, 2005a. *Determination of the distribution of Florida’s remnant sawfish population andidentification of areas critical to their conservation.* Final report. Florida Fish and Wildlife Conservation Commission, Tallahassee, Florida.

Simpkins, M. A., L. M. Hiruki-Raring, G. Sheffield, J. M. Grebmeier, and J. Bengtson, 2003. Habitat selection by ice-associated pinnipeds near St. Lawrence Island, Alaska in March 2001. *Polar Biology*, Vol 26, pp 577–586.

Sirovic, A., 2006. *Blue and fin whale acoustics and ecology off Antarctic Peninsula*. A dissertation submitted in partial satisfaction for the requirements of Doctor of Philosophy in Oceanography. University of California, San Diego.

Sisneros, J. A., and A. H. Bass, 2003. Seasonal placticity of peripheral auditory frequency sensitivity. T*he Journal of Neuroscience*, Vol 23, No 3, pp 1049–1058.

Sjare, B., I. Stirling, and C. Spencer, 2003. Structural variation in the songs of Atlantic walruses breeding in the Canadian High Arctic. *Aquatic Mammals,* Vol 29, No 2, pp 297–318.

Sjöberg, M., and J. P. Ball, 2000. Grey seal, *Halichoerus grypus*, habitat selection around haulout sites in the Baltic Sea: Bathymetry or central-place foraging. *Canadian Journal of Zoology*, Vol 78, pp 1661–1667.

Skaug, H. J., and T. Schweder. 1999. Hazard models for line transect surveys with independent observers. *Biometrics*, Vol 55, pp 29–36.

Skaug, H. J., N. Øien, T. Schweder, and G. Bøthun, 2004. Abundance of minke whales (Balaenoptera acutorostrata) in the Northeast Atlantic: Variability in time and space. *Canadian Journal of Fisheries and Aquatic Sciences*, Vol 61, pp 870–886.

Skov, H., J. Durinck, and D. Bloch, 2003. Habitat characteristics of the shelf distribution of the harbour porpoise (*Phocoena phocoena*) in the waters around the Faroe Islands during summer. North Atlantic Marine Mammal Commission (NAMMCO) *Scientific Publications*, Vol 5, pp 31–40.

Slay, C., 2002. Personal communication via e-mail between Mr. Chris Slay, New England Aquarium, and Ms. Dagmar Fertl, Geo-Marine, Inc., Plano, Texas, on 1 August 2002.

Slijper, E. J., W. L. van Utrecht, and C. Naaktgeboren, 1964. Remarks on the distribution and migration of whales, based on observations from Netherlands ships. *Bijdragen Tot de Dierkunde*, Vol 34, pp 3–93.

Slocum, C. J., and R. Schoelkopf, 2001. Population dynamics of phocid seals wintering in New Jersey and the Mid-Atlantic region (U.S.), 1993-2001, in *Abstracts, Fourteenth Biennial Conference on the Biology of Marine Mammals.* November 28 – December 3, 2001. Vancouver, British Columbia. p 199.

Slocum, C. J., R. Schoelkopf, S. Tulevech, M. Stevens, S. Evert, and M. Moyer, 1999. Seal populations wintering in New Jersey (USA) have increased in abundance and diversity, in *Abstracts, Thirteenth Biennial Conference on the Biology of Marine Mammals*. November 28 – December 3, 1999. Wailea, Maui. p 174–175.

Slocum, C., R. Schoelkopf, and N. Furina, 2003. Patterns of seasonal stranding in the true seal populations in the western mid-Atlantic region (USA): Abundance, diversity, location, seasonality, age and gender, in *Abstracts, Fifteenth Biennial Conference on the Biology of Marine Mammals*. 14–19 December 2003. Greensboro, North Carolina. p 152.

Slotterback, J. W., 2002. Band-rumped Storm-Petrel (*Oceanodroma castro*) and Tristram's Storm-Petrel (Oceanodroma tristrami) in *The Birds of North America*, *No. 673*, A. Poole and F. Gill, eds. The Birds of North America, Inc.: Philadelphia, PA.

Smith, M. E., A. S. Kane, and A. N. Popper, 2004a. Acoustical stress and hearing sensitivity in fishes: does the linear threshold shift hypothesis hold water? *The Journal of Experminental Biology*, Vol 207, pp 3591–3602.

Smith, M. E., A. S. Kane, and A. N. Popper, 2004b. Noise-induced stress response and hearing loss in goldfish (*Carassius auratus*). *The Journal of Experminental Biology*, Vol 207, pp 427–435.

Smith, R. J., and A. J. Read, 1992. Consumption of euphausiids by harbor porpoise (*Phocoena phocoena*) calves in the Bay of Fundy. *Canadian Journal of Zoology*, Vol 70, pp 1629–1632.

Smith, T. D., J. Allen, P. J. Clapham, P. S. Hammond, S. Katona, F. Larsen, J. Lien, D. Mattila, P J. Palsbøll, J. Sigurjónsson, P. T. Stevick, and N. Øien, 1999. An ocean-basin-wide mark-recapture study of the North Atlantic humpback whale (*Megaptera novaeangliae*). *Marine Mammal Science*, Vol 15, No 1, pp 1–32.

Smith, T. D., R. B. Griffin, G. T. Waring, and J. G. Casey, 1996. Multispecies approaches to management of large marine predators in *The northeast shelf ecosystem: Assessment, sustainability, and management. Cambridge: Blackwell Science*, K. Sherman, N.A. Jaworski, and T.J. Smayda. pp 467-490

Smith, T. G., and I. Stirling, 1975. The breeding habit of the ringed seal (*Phoca hispida*). The birth lair and associated structures. *Canadian Journal of Zoology*, Vol 53, pp 1297–1305.

Smultea, M. A., 1994. Segregation by humpback whale (*Megaptera novaeangliae*) cows with a calf in coastal habitat near the island of Hawaii. *Canadian Journal of Zoology*, Vol 72, pp 805–811.

Smultea, M. A., J. R. Mobley, Jr., D. Fertl, and G. L. Fulling, 2008. An unusual reaction and other observations of sperm whales near fixed-wing aircraft. *Gulf and Caribbean Research*, Vol 20, pp 75–80.

Song, J., D. A. Mann, P. A. Cott, B. W. Hanna, and A. Popper. 2008. The inner ears of Northern Canadian freshwater fishes following exposure to seismic air gun sounds. *Journal of the Acoustical Society of America*, 124 (2), pp 1360-1366.

Song, J., A. Mathieu, R. F. Soper, and A. N. Popper, 2006. Structure of the inner ear of bluefin tuna, *Thunnus thynnus*. *Journal of Fish Biology*, Vol 68, pp 1767–1781.

South Atlantic Fishery Management Council (SAFMC), 1998. Final Habitat Plan For The South Atlantic Region: Essential Fish Habitat Requirements For Fishery Management Plans Of The South Atlantic Fishery Management Council. Retrieved from http://ocean.floridamarine.org/efh_coral/pdfs/Habitat_Plan/HabitatPlanTOC.pdf, on 10 June 2008.

South Atlantic Fishery Management Council (SAFMC), 2002a. Final fishery management plan for pelagic *Sargassum* habitat of the South Atlantic Region. Second revised final. Charleston: South Atlantic Fishery Management Council.

South Atlantic Fishery Management Council (SAFMC), 2007. *Fishery Management Plan for Pelagic Sargassum Habitat in the South Atlantic Region*. Retrieved from www.safmc.net/library/sargassum, on 2 July 2007.

South Atlantic Fishery Management Council (SAFMC). 2008. Deepwater Corals: What Are They? Retrieved from http://www.safmc.net/ecosystem/HabitatManagement/DeepwaterCorals/tabid/229/Default.aspx, on 9 June 2008.

South Carolina State Ports Authority (SCSPA), 2008. Port of Charleston. Retrieved from www.port-of-charleston.com on 21 April 2008.

Southall, B. L., 2005. Final Report of the 2004 NOAA symposium, *Shipping Noise and Marine Mammals: A Forum for Science, Management and Technology*. National Oceanographic and Atmospheric Administration. 40 pp.

Southall, B. L., 2007. Personal communication via email between Dr. Brandon Southall, NMFS, Silver Spring, Maryland, and Ms. Dagmar Fertl, Geo-Marine, Inc., Plano, Texas, 22 April.

Southall, B. L., R. J. Schusterman, R. J., and D. Kastak, D. 2000. Masking in three pinnipeds: Underwater low frequency critical ratios. *Journal of.Acoustical Society of America*, Vol 108, pp 1322–1326.

Southall, B. L., R. J. Schusterman, R. J., and D. Kastak, D., 2003. 'Auditory masking in three pinnipeds: aerial critical ratios and direct critical bandwidth measurements. *Journal of.Acoustical Society of America*, Vol 114, pp 1660–1666.

Southall, B. L., R. Braun, F. M. D. Gulland, A. D. Heard, R. Baird, S. Wilkin and T. K. Rowles, 2006. *Hawaiian melon-headed whale (*Peponocephala electra*) mass stranding event of July 3-4, 2004.* NOAA Technical Memorandum NMFS-OPR-31. 73 pp.

Southall, B. L., A. E. Bowles, W. T. Ellison, J. J. Finneran, R. L. Gentry, C. R. Greene Jr., D. Kastak, D. R. Ketten, J. H. Miller, P. E. Nachtigall, W. J. Richardson, J. A. Thomas, and P. L. Tyack, 2007. Marine mammal noise exposure criteria: initial scientific recommendations. *Aquatic Mammals*, Vol 33, No 4, pp 411–521.

Spotila, J. R., A. E. Dunham, A. J. Leslie, A. C. Steyermark, P. T. Plotkin, and F. V. Paladino, 1996. Worldwide population decline of *Dermochelys coriacea*: Are leatherback turtles going extinct? *Chelonian Conservation and Biology*, Vol 2, No 2, pp 209–222.

Sprague, M. W., and J. J. Luczkovich, 2004. Measurement of an individual silver perch, *Bairdiella chrysoura*, sound pressure level in a field recording. *Journal of the Acoustical Society of America*, Vol 116, No 5, pp 3186–3191.

St. Aubin, D. J., 2002. *Further assessment of the potential for fishery-induced stress on dolphins in the eastern tropical Pacific*. Southwest Fisheries Science Center. pp 1–12.

St. Aubin, D. J., and Dierauf, L. A., 2001. Stress and Marine Mammals, in *Marine Mammal Medicine (2nd edition)*, eds. Dierauf, L. A. and F. M. D. Gulland, 253-269.CRC Press: Boca Raton, Florida.

St. Aubin, D. J., and J. R. Geraci, 1988. Capture and handling stress suppresses circulating levels of thyroxine (T4) and triiodothyronine (T3) in beluga whales *Delphinapterus leucas*. *Physiological Zoology*,Vol 61, pp 170–175.

St. Aubin, D. J., and J. R. Geraci, 1989. Adaptive changes in hematologic and plasma chemical constituents in captive beluga whales, *Delphinapterus leucas*. *Canadian Journal of Fisheries and Aquatic Sciences*, Vol 46, pp 796–803.

St. Aubin, D. J., S. H. Ridgway, R. S. Wells, and H. Rhinehart, 1996. Dolphin thyroid and adrenal hormones: Circulating levels in wild and semidomesticated *Tursiops truncatus*, and influence of sex, age, and season. *Marine Mammal Science*, Vol 12, pp 1–13.

St. Aubin, D. J., S. DeGuise, P. R. Richard, T. G. Smith, and J. R. Gerack, 2001. Hematology and plasma chemistry as indcators of health and ecological status in beluga whales, *Delphinapterus leucas. Arctic*, Vol 54, pp 317–331.

Staats, E., 2003. Deep Trouble: An industry, sport on the hook. *Naples Daily News*. Retrieved from http://web.naplenews.com/03/09/naples/e1682a.htm, on 8 January 2007.

Stacey, P. J., and R. W. Baird, 1991. Status of the false killer whale, *Pseudorca crassidens*, in Canada. *Canadian Field-Naturalist*, Vol 105, No 2, pp 189–197.

Stacey, P. J., S. Leatherwood, and R.W. Baird, 1994. *Pseudorca crassidens*. *Mammalian Species*, Vol 456, pp 1–5.

Stafford, K. M., S. E. Moore, and C. G. Fox, 2005. Diel variation in blue whale calls recorded in the eastern tropical Pacific. *Animal Behaviour*, Vol 69, pp 951–958.

Stafford, K. M., S. L. Nieukirk, and C. G. Fox, 2001. Geographic and seasonal variation of blue whale calls in the North Pacific. *Journal of Cetacean Research and Management*, Vol 3, No 1, pp 65–76.

Standora, E. A., J. R. Spotila, J. A. Keinath, and C. R. Shoop, 1984. Body Temperatures, Dive Cycles, and Movement of a Subadult Leatherback Turtle, *Dermochelys coriacea*. *Herpetelogica*, Vol 40, pp 169–176.

Stanley, H. F., S. Casey, J. M. Carnahan, S. Goodman, J. Harwood, and R. K. Wayne, 1996. Worldwide patterns of mitochondrial DNA differentiation in the harbor seal (*Phoca vitulina*). *Molecular Biology and Evolution*, Vol 13, pp 368–382.

Stedman, S. J., 2000. Horned Grebe (*Podiceps auritus*), in *The Birds of North America, No. 505*, A. Poole and F. Gill, eds. The Birds of North America, Inc: Philadelphia, PA.

Steel, C., and J. G. Morris, 1982. The West Indian manatee: An acoustic analysis. *American Zoologist*, Vol 22, No 4, pp 925–926.

Steinback, S., B. Gentner, and J. Castle, 2004. T*he Economic Importance of Marine Angler Expenditures in the United States*. NOAA Professional Paper NMFS 2. pp 169.

Stenson, G. B., R. A. Myers, W. G. Warren, and I. H. Ni, 1996. Pup production of hooded seals (*Cystophora cristata*) in the northwest Atlantic. *NAFO Scientific Council Studies*, Vol 26, pp 105–114.

Stephan, C. D., and T. Bigford, 1997. *Atlantic Coastal Submerged Aquatic Vegetation: A Review of its Ecological Role, Anthropogenic Impacts State Regulation, and Value to Atlantic Coastal Fish Stocks.* Atlantic States Marine Fisheries Commission, National Marine Fisheries Service Habitat Management Series #1. Eastern Gulf of Mexico Resource Summary Report. September 1997.

Stern, S. J., 1992. Surfacing rates and surfacing patterns of minke whales (*Balaenoptera acutorostrata*) off central California, and the probability of a whale surfacing within visual range. *Reports of the International Whaling Commission*, Vol 42, No 3, pp 385.

Stern, S. J., 2002. Migration and movement patterns, in *Encyclopedia of Marine Mammals*, W. F. Perrin, B. Würsig, and J. G. M. Thewissen, eds.Academic Press: San Diego, California. pp 742–748.

Stevick, P. T., and T. W. Fernald, 1998. Increase in extralimital records of harp seals in Maine. *Northeastern Naturalist*, Vol 5, No 1, pp 75–82.

Stevick, P. T., B. J. McConnell, and P. S. Hammond, 2002. Patterns of movement, in *Marine Mammal Biology: An Evolutionary Approach*, A. R. Hoelzel, ed.. Oxford, United Kingdom: Blackwell Science. pp 185–216.

Stevick, P. T., J. Allen, M. Bérubé, P. J. Clapham, S .K. Katona, F. Larsen, J. Lien, D. K. Mattila, P. J. Palsbøll, J. Robbins, J. Sigurjónsson, T. D. Smith, N. Øien, and P. S. Hammond, 2003b. Segregation of migration by feeding ground origin in North Atlantic humpback whales (*Megaptera novaeangliae*). *Journal of Zoology*, London, Vol 259, pp 231–237.

Stevick, P. T., J. Allen, P. J. Clapham, N. Friday, S. K. Katona, F. Larsen, J. Lien, D. K. Mattila, P. J. Palsbøll, J. Sigurjónsson, T. D. Smith, N. Øien, and P. S. Hammond, 2003a. North Atlantic humpback whale abundance and rate of increase four decades after protection from whaling. *Marine Ecology Progress Series*, Vol 258, pp 263–273.

Stewart, B. S., and S. Leatherwood, 1985. Minke whale *Balaenoptera acutorostrata* Lacepede, 1804, in *Handbook of Marine Mammals, Vol 3: The Sirenians and Baleen Whales*, S. H. Ridgway and R. Harrison, eds. Academic Press: San Diego. pp 91-136.

Stewart, B. S., and S. Leatherwood, 1985. Minke whale *Balaenoptera acutorostrata* Lacépède, 1804, in *Handbook of Marine Mammals, Vol 3: The Sirenians and Baleen Whales,* S. H. Ridgway and R. Harrison, eds. Academic Press: San Diego, California. pp 91–136.

Stimpert, A. K., T. V. N. Cole, R. M. Pace III, and P. J. Clapham, 2003. Distributions of four baleen whale species in the northwest Atlantic Ocean based on large-scale aerial survey data, in *Abstracts, Fifteenth Biennial Conference on the Biology of Marine Mammals*. 14–19 December 2003. Greensboro, North Carolina. p 157.

Stimpert, A. K., D. N. Wiley, W. W. L. Au, M. P. Johnson, and R. Arsenault, 2007. 'Megapclicks': Acoustic click trains and buzzes produced during night-time foraging of humpback whales (*Megaptera novaeangliae*). Biology Letters, No. 3, pp 467–470.

Stirling, I., 1973. Vocalization in the ringed seal (*Phoca hispida*). *Journal of the Fisheries Research Board of Canada*, Vol 30, No 10, pp 1592–1594.

Stirling, I., W. Calvert, and H. Cleator, 1983. Underwater vocalizations as a tool for studying the distribution and relative abundance of wintering pinnipeds in the high Arctic. *Arctic*, Vol 36, pp 262–274.

Stock, M. K., E. H Lanphier, D. F. Anderson, L. C. Anderson, T. M. Phernetton, and J. H. Rankin, 1980. Responses of fetal sheep to simulated no-decompression dives. *Journal of Applied Physiology*, Vol 48, No 5, pp 776–780.

Stockin, K. A., R. S. Fairbairns, E. C. M. Parsons, and D. W. Sims, 2001. Effects of diel and seasonal cycles on the dive duration of the minke whale (*Balaenoptera acutorostrata*). *Journal of the Marine Biological Association of the United Kingdom*, Vol 81, pp 189–190.

Stone, G. S., L. Cavagnaro, A. Hutt, S. Kraus, K. Baldwin, and J. Brown, 2000. *Reactions of Hector's dolphins to acoustic gillnet pingers*. Published client report, contract 3071, funded by Conservation Services Levy. Department of Conservation, Wellington. p 29.

Stone, G. S., S. D. Kraus, J.H. Prescott, and K. W. Hazard, 1988. Significant aggregations of the endangered right whale, *Eubalaena glacialis,* on the continental shelf of Nova Scotia. *Canadian Field-Naturalist*, Vol 102, No 3, pp 471–474.

Stone, G. S., S. K. Katona, A. Mainwaring, J. M. Allen, and H. D. Corbett, 1992. Respiration and surfacing rates for finback whales (*Balaenoptera physalus*) observed from a lighthouse tower. *Reports of the International Whaling Commission*, Vol 42, pp 739–745.

Street, M. W., A. S. Deaton, W. S. Chappell, and P. D. Mooreside, 2005. *North Carolina Coastal Habitat Protection Plan*. North Carolina Department of Environment and Natural Resources, Division of Marine Fisheries, Morehead City, North Carolina. p 656.

SUEZ Energy North America, 2006. Neptune LNG LLC. Retrieved from http://www.suezenergyna.com/ourcompanies/lngna-neptune.shtml, on 17 October 2007.

SUEZ Energy North America, 2007a. Distrigas of Massachusetts LLC. Retrieved from http://www.tractebelusa.com/ourcompanies/lngna-domac.shtml on 17 October 2007.

SUEZ Energy North America, 2007b. Neptune LNG Deepwater Port Project Receives License from U.S. Maritime Administration. Retrieved from http://www.suezenergyna.com/press/documents/Neptune20070326.pdf, on 16 May 2008.

SUEZ Energy North America, 2008a. Suez LNG NA. Retrieved from http://www.suezenergyna.com/ourcompanies/lngna-neptune.shtml, on 16 May 2008.

SUEZ Energy North America, 2008b. Neptune: A New Wave in Natural Gas Delivery. Retrieved from http://www.suezenergyna.com/ourcompanies/NeptuneMech.pdf, on 16 May 2008.

Swingle, W. M., S. G. Barco, T. D. Pitchford, W. A. McLellan, and D. A. Pabst, 1993. Appearance of juvenile humpback whales feeding in the nearshore waters of Virginia. *Marine Mammal Science*, Vol 9, No 3, pp 309–315.

Szymanski, M. D., D. E. Bain, K. Kiehl, S. Pennington, S. Wong, and K. R. Henry, 1999. Killer whale (*Orcinus orca*) hearing: Auditory brainstem response and behavioral audiograms. *Journal of the Acoustical Society of America*, Vol 106, No 2, pp 1134–1141.

Taylor, B. L., M. Martinez, T. Gerrodette, J. Barlow, and Y. N. Hrovat. 2007. Lessons from monitoring trends in abundance of marine mammals. *Marine Mammal Science*, Vol 23, No 1, pp 157–175.

Teilmann, J., E. W. Born, and M. Acquarone, 1999. Behaviour of ringed seals tagged with satellite transmitters in the North Water polynya during fast-ice formation. *Canadian Journal of Zoology*, Vol 77, pp 1934–1946.

Teilmann, J., J. Tougaard, L. Miller, T. Kirketerp, K. Hansen, S. Labberté, 2006. Reaction of captive harbour porpoises (*phocoena phocoena*) to pinger - like sounds. *Marine Mammal Science,* Vol 22, pp 240–260.

Teloni, V., 2005. Patterns of sound production in diving sperm whales in the northwestern Mediterranean. *Marine Mammal Science,* Vol 21, No 3, pp 446–457.

Teloni, V., W. M. X. Zimmer, and P.L. Tyack, 2005. Sperm whale trumpet sounds. *Bioacoustics*, Vol 15, No 2, pp 163–174.

Temte, J. L., M. A. Bigg, and O. Wiig, 1991. Clines revisited: The timing of pupping in the harbour seal (*Phoca vitulina*). *Journal of Zoology, London*, Vol 224, pp 617–632.

Terhune, J. and S. Turnbull, 1995. Variation in the psychometric functions and hearing thresholds of a harbour seal, in *Sensory Systems of Aquatic Mammals*, R. A. Kastelein, J. A. Thomas, and P. E. Nachtigall, eds. Woerden, The Netherlands: De Spil Publishers. pp 81–93.

Terhune, J. M., and K. Ronald, 1971. The harp seal, *Pagophilus groenlandicus* (Erxleben, 1777). The air audiogram. *Canadian Journal of Zoology*, Vol 49, No 3, pp 385–390.

Terhune, J. M., and K. Ronald, 1972. The harp seal, *Pagophilus groenlandicus* (Erxleben, 1777). III. The underwater audiogram. *Canadian Journal of Zoology*, Vol 50, No 5, pp 565–569.

Terhune, J. M., and K. Ronald, 1973. Some hooded seal (*Cystophora cristata*) sounds in March. *Canadian Journal of Zoology*, Vol 51, No 3, pp 319–321.

Terhune, J. M., and K. Ronald, 1975. Underwater hearing sensitivity of two ringed seals (*Pusa hispida*). *Canadian Journal of Zoology*, Vol 53, pp 227–231.

Terhune, J. M., and K. Ronald, 1976. The upper frequency limit of ringed seal hearing. *Canadian Journal of Zoology*, Vol 54, pp 1226–1229.

Terhune, J. M., and K. Ronald, 1986. Distant and near-range functions of harp seal underwater calls. *Canadian Journal of Zoology*, Vol 64, pp 1065–1070.

Terhune, J. M., 1985. A linear decrease of harbor seal numbers. *Marine Mammal Science,* Vol 1, No 4, pp 340–341.

Terhune, J. M., 1988. Detection thresholds of a harbour seal to repeated underwater high-frequency, short duration sinusoidal pulses. *Canada Journal of Zoology*,Vol 66, pp 1578–1582

Terhune, J. M., 1999. Right whales and ship noises. *Marine Mammal Science*, Vol 15, No 1, pp 256–258.

Tershy, B. R., 1992. Body size, diet, habitat use, and social behavior of *Balaenoptera* whales in the Gulf of California. *Journal of Mammalogy*, Vol 73, No 3, pp 477–486.

Tershy, B. R., J. Urbán-Ramírez, D. Breese, L. Rojas-Bracho, and L. T. Findley, 1993. Are fin whales resident to the Gulf of California? Ridgway, S.H. and R. Harrison, eds. Vol 1, pp 69–72.

Testaverde, S., and J. G. Mead, 1980. Southern distribution of the Atlantic whitesided dolphin, (*Lagenorhynchus acutus*) in the western North Atlantic. *Fishery Bulletin,* Vol 78, No 1, pp 169.

TetraTech EC, Inc., 2008. Northeast Gateway Deepwater Port Project Incidental Harassment Authorization Request. February.

TEWG (Turtle Expert Working Group), 1998. *An Assessment of the Kemp's Ridley (*Lepidochelys kempii*) and Loggerhead (*Caretta caretta*) Sea Turtle Populations in the Western North Atlantic*. National Oceanic and Atmospheric Administration Technical Memorandum

TEWG (Turtle Expert Working Group), 2000. *Assessment Update for the Kemp's Ridley and Loggerhead Sea Turtle Populations in the Western North Atlantic*. National Oceanic and Atmospheric Administration Technical Memorandum NMFS-SEFSC-444.

Texas General Land Office (TGLO), 2005. News Release: Texas Lands Historic Offshore Wind Project. 24 October 2005. Document obtained at http://www.glo.state.tx.us/news/archive/2005/jpgs/Offshore-FINAL-PR-10-24-05.pdf, on 21 May 2007.

Texas General Land Office (TGLO), 2006. News Release: Patterson Signs Lease for Biggest Offshore Wind Farm in U.S. History. May 11. 2006. Document obtained at http://www.glo.state.tx.us/news/archive/2006/docs/WL-2-PR-FINAL-05-09-06.pdf, on 21 May 2007.

Texas Historical Commission (THC), 2007. LaSalle Shipwreck Project. Retrieved from http://www.thc.state.tx.us/belle/, on 19 June 2007.

Texas Parks and Wildlife Department (TPWD), 2006. Boating Facts. Retrieved from http://www.tpwd.state.tx.us/learning/boater_education/boating_facts, on 24 January 2006.

Texas Scripps Newspapers, 2004. Local Killer Whale Sighting Goes Down in Record Book. *Corpus Christi Caller-Times*. Retrieved from http://www.caller.com/ccct/kris_tv/article/0,1641,CCCT_995_2589032,00.

Texas Workforce Commission, 2005. State of Texas Petroleum Refining and Chemical Products Cluster Assesment. Retrieved from http://www.texasindustryprofiles.com/PDF/twcClusterReports/TexasPetroleumRefiningandChemicalProductsCluster.pdf, on 25 January 2007.

Thayer, G. W., M. S. Fonseca, and J. W. Kenworthy, 1997. Ecological Value of Seagrasses: A Brief Summary for the ASMFC Habitat Committee's SAV Subcommittee. NOAA/NMFS Southeast Fisheries Science Center, Beaufort Laboratory.

Thayer, V. G., A. J. Read, A. A. Hohn, W. A. McLellan, D. A. Pabst, and K. A. Rittmaster. 1999. Reproductive seasonality of bottlenose dolphins, *Tursiops truncatus*, in North Carolina. in *Abstracts, Thirteenth Biennial Conference on the Biology of Marine Mammals*. 28 November-3 December, 1999. Wailea, Maui. p 183,

Thayer, V. G., A. J. Read, A. S. Friedlaender, D. R. Colby, A. A. Hohn, W. A. McLellan, D. A. Pabst, J. L. Dearolf, N. I. Bowles, J. R. Russell, and K. A. Rittmaster, 2003. Reproductive seasonality of western Atlantic bottlenose dolphins off North Carolina, U.S.A. *Marine Mammal Science*, Vol 19, No 4, pp 617–629.

The Port of Houston Authority, 2006. General Information. Retrieved from http://www.portofhouston.com/geninfo/overview1.html, on 7 January 2007.

The Reef Environmental Education Foundation (REEF), 2001. REEF's Survey Project Database. Retrieved from http://www.reef.org/data/data.htm.

The University of Rhode Island, Discovery of Sound in the Sea (DOSITS), 2007. Science of Sound in the Sea. Retrieved from http://www.dosits.org/science/ssea/2.htm, on 2 July 2007.

Thode, A., D. K. Mellinger, S. Stienessen, A. Martinez, and K. Mullin, 2002. Depth-dependent acoustic features of diving sperm whales (*Physeter macrocephalus*) in the Gulf of Mexico. *Journal of the Acoustical Society of America*, Vol 112, No 1, pp 308–321.

Thomas, J. A., J. L. Pawloski, and W. W. L. Au, 1990. Masked hearing abilities in a false killer whale (*Pseudorca crassidens*), in *Sensory abilities of cetaceans*, J. Thomas and R. Kastelein, eds. Plenum Press: New York. pp 395–404.

Thomas, J. A., Kastelein, R. A., and Awbrey, F. T., 1990b. Behavior and blood catecholamines of captive belugas during playbacks of noise from an oil drilling platform, *Zoo Biology*, Vol 9, pp 393–402.

Thomas, J., Moore, P., Withrow, R., and Stoermer, M., 1990a. Underwater audiogram of a Hawaiian monk seal (*Monachus schauinslandi*). *Journal of the Acoustical Society of America*, Vol 87, pp 417–420.

Thomas, J., N. Chun, W. Au, and K. Pugh, 1988. Underwater audiogram of a false killer whale (*Pseudorca crassidens*). *Journal of the Acoustical Society of America*, Vol 84, No 3, pp 936–940.

Thompson, B. C., J. A. Jackson, J. Burger, L. A. Hill, E. M. Kirsch, and J. L. Atwood, 1997. Least Tern (*Sterna antillarum*) in *The Birds of North America, No. 290*, A. Poole and F. Gill, eds. The Academy of Natural Sciences, Philadelphia, PA, and The American Ornithologists' Union, Washington, D.C.

Thompson, D., and M. A. Fedak, 1993. Cardiac responses of grey seals during diving at sea. *Journal of Experimental Biology*, Vol 174, pp 139–154.

Thompson, D., P. S. Hammon, K. S. Nicholas, and M. A. Fedak, 1991. Movements, diving and foraging behaviour of grey seals (*Halichoerus grypus*). *Journal of Zoology, London*, Vol 224, pp 223–232.

Thompson, N. B., 1991. *Loggerhead turtles in the Gulf of Mexico.* National Marine Fisheries Service, R. J. Urick, Southeast Fisheries Science Center, Pelagic distributions: Miami, Florida.

Thompson, N. B., 1991. *Loggerhead turtles in the Gulf of Mexico: Pelagic distributions.* National Marine Fisheries Service, Southeast Fisheries Science Center: Miami, Florida.

Thompson, N. B., J. R. Schmid, S. P. Epperly, M. L. Snover, J. Braun-McNeill, W. N. Witzell, W. G. Teas, L. A. Csuzdi, and R. A. Myers. 2001. Stock assessment of leatherback sea turtles of the western North Atlantic, in *Stock assessments of loggerhead and leatherback sea turtles and an assessment of the impact of the pelagic longline fishery on the loggerhead and leatherback sea turtles of the western North Atlantic*. National Marine Fisheries Service-Southeast Fisheries Science Center (NMFS-SEFSC), ed. NOAA Technical Memorandum NMFS-SEFSC-455. pp 67–104.

Thompson, P. M., D. Miller, R. Cooper, and P. S. Hammond, 1994. Changes in the distribution and activity of female harbour seals during the breeding season: Implications for their lactation strategy and mating patterns. *Journal of Animal Ecology*, Vol 63, pp 24–30.

Thompson, P. M., G. J. Pierce, J. R. G. Hislop, D. Miller, and J. S. Diack, 1991. Winter foraging by common seals (*Phoca vitulina*) in relation to food availability in the inner Moray Firth, N.E. Scotland. *Journal of Animal Ecology*, Vol 60, pp 283–294.

Thompson, P. O., W. C. Cummings, and S. J. Ha, 1986. Sounds, source levels, and associated behavior of humpback whales, southeast Alaska. *Journal of the Acoustical Society of America*, Vol 80, No 3, pp 735–740.

Thomsen, F., F. Ugarte, and P. G. H. Evans, eds. 2005. Proceedings of the workshop on estimation of g(0) in line-transect surveys of cetaceans held at the European Cetacean Society's 18th Annual Conference, Vildmarkshotellet at Kolmården Djur Park, Kolmården, Sweden, 28th March, 2004. *European Cetacean Society Newsletter*, Special Issue 44, pp 1–46.

Thomson, D. H. and W. J. Richardson, 1995. Marine mammal sounds, in *Marine Mammals and Noise*, W. J. Richardson, C. R. Greene, Jr., C. I. Malme, and D. H. Thomson, eds. Academic Press: San Diego. pp 159–204.

Threlfall, W., 1978. First record of the Atlantic leatherback turtle (*Dermochelys coriacea*) from Labrador. *Canadian Field-Naturalist*, Vol 92, No 3, pp 287.

Thurman, H. V., 1997. *Introductory oceanography. 8th ed*.Prentice Hall: Upper Saddle River, New Jersey.

Thurman, H., 1994. *Introductory Oceanography, 7th ed.* Macmillan: New York.

Tomás, J., Formia, A., Fernández, M. & Raga, J.A., 2003. Occurrence and genetic analysis of a Kemp's ridley seaturtle (*Lepidochelys kempii*) in the Mediterranean Sea. *Scientia Marina*, Vol 67, pp 367–369.

Torres, L. G., P. E. Rosel, C. D'Agrosa, and A. J. Read, 2003. Improving management of overlapping bottlenose dolphin ecotypes through spatial analysis and genetics. *Marine Mammal Science*, Vol 19, No 3, pp 502–514.

Torres, L. G., W. A. McLellan, E. Meagher, and D. A. Pabst, 2005. Seasonal distribution and relative abundance of bottlenose dolphins, *Tursiops truncatus*, along the US mid-Atlantic Coast. *Journal of Cetacean Research and Management*, Vol 7, No 2, pp 153–161.

Tove, M., 1995. Live sightings of *Mesoplodon cf. M. mirus*, True's beaked whale. *Marine Mammal Science*, Vol 11, No 1, pp 80–85.

Townsend, C. H., 1935. The distribution of certain whales as shown by logbook records of American whaleships. *Zoologic*, Vol 19, pp 1–50.

Trainer, V. L. and D. G. Baden, 1999. High affinity binding of red tide neurotoxins to marine mammal brain. *Aquatic Toxicology*, Vol 46, pp 139–148.

Trites, A. W., V. Christensen, and D. Pauly, 1997. Competition between fisheries and marine mammals for prey and primary production in the Pacific Ocean. *Journal of Northwest Atlantic Fishery Science*, Vol 22, pp 173–187.

True, F. W., 1885. The bottle-nose dolphin, *Tursiops tursio*, as seen at Cape May, *New Jersey. Science*, Vol 5. No 116, pp 38–339.

Tucholke, B. E., 1987. Submarine geology. Pages 56–113 in J.D. Milliman and W.R. Wright, eds. The marine environment of the U.S. Atlantic continental slope and rise. Boston/Woods Hole, Massachusetts: Jones and Bartlett Publishers, Inc.

Turgeon, D. D., A. E. Bogan, E. V. Coan, W. K. Emerson, W. G. Lyons, W. L. Pratt, C. F. E. Roper, A. Scheltema, F. G. Thompson, and J. D. Williams, 1988. Common and scientific names of aquatic invertebrates of the United States and Canada: mollusks. *American Fisheries Society Special Publication*, Vol 16, p 277.

Turl, C. W., 1993. Low-frequency sound detection by a bottlenose dolphin. *Journal of the Acoustical Society of America*, Vol 94, No 5, pp 3006–3008.

Turnbull, S. D., and J. Terhune, 1990. White noise and pure tone masking of pure tone thresholds of a harbor seal listening in air and under water. *Canadian. Journal of Zoology*, Vol. 68, pp 2090–2097.

Turnpenny, A. W. H., and J. R. Nedwell, 1994. The effects on marine fish, diving mammals and birds of underwater sound generated by seismic surveys. FARL Report Reference: FCR 089/94, October 1994. Accessed online at: http://www.subacoustech.com/downloads/reports/FCR089_94.pdf.

Turtle Expert Working Group (TEWG), 1998. *An assessment of the Kemp's ridley (*Lepidochelys kempii*) and loggerhead (*Caretta caretta*) sea turtle populations in the western North Atlantic.* NOAA Technical Memorandum NMFS-SEFSC-409, pp 1–96.

Turtle Expert Working Group (TEWG), 2000. *Assessment update for the Kemp's ridley and loggerhead sea turtle populations in the western North Atlantic*. NOAA Technical Memorandum NMFS-SEFSC-444, pp 1–115.

Turtle Island Restoration Network (TIRN), 2002. Environmentalists call for stronger protections for loggerhead populations. Press release, 11 January 2001. Forest Knolls, California: Turtle Island Restoration Network.

Twichell, D. C., B. Butman, and R.S. Lewis, 1987. Shallow structure, surficial geology, and the processes currently shaping the bank, in *Georges Bank*, R.H. Backus, ed.The MIT Press: Cambridge, Massachusetts. pp 31–37.

Tyack, P., and H. Whitehead, 1983. Male competition in large groups of wintering humpback whales. *Behaviour*, Vol 83, pp 132–153.

Tyack, P. L., and E. H. Miller, 2002. Vocal anatomy, acoustic communication and echolocation. in *Marine mammal biology: An evolutionary approach*, Hoelzel, R., ed. Bodmin, Cornwall, U.K.: Blackwell Science, Ltd. pp 142–184.

Tyack, P. L., M. Johnson, N. Aguilar Soto, A. Sturlese, and P. T. Madsen, 2006. Extreme diving of beaked whales. *Journal of Experimental Biology*, Vol 209, pp 4238–4253.

Tyack, P., 1986. Population biology, social behavior and communication in whales and dolphins. *Trends in Ecology and Evolution*, Vol 1, No 6, pp 144–150.

Tynan, C. T., and D. P. DeMaster, 1997. Observations and predictions of Arctic climatic change: Potential effects on marine mammals. *Arctic*, Vol 50, No 4, pp 308–322.

U.S. Air Force, 1999. *Cape San Blas Final Programmatic Environmental Assessment*. Air Armament Center, 46 TW/XPE Range Environmental Planning Office, Eglin Air Force Base, Florida.

U.S. Air Force, 2000. *Conversion of Two F-15 Fighter Squadrons To F-22 Fighter Squadrons At Tyndall AFB, Florida Final Environmental Impact Statement*. May 2000.

U.S. Air Force, 2002. *Eglin Gulf Test and Training Range Programmatic Environmental Assessment*. Air Armament Center, 46 TW/XPE Range Environmental Planning Office, Eglin Air Force Base, Florida.

U.S. Air Force, 2004a. Air Force AFF813 request to partner with Gulf Fiber Corp. to bring a fiber optic cable from the Gulf of Mexico into Building 8320 at site A3.

U.S. Air Force, 2004b. *Naval Explosive Ordnance Training School (NEODS) Training Operations at Eglin AFB, FL, Biological Assessment*. Natural Resources Branch, Eglin AFB, Florida.

U.S. Air Force, 2004c. *B-61 Joint Test Assembly (JTA) Weapons System Evaluation Program (WSEP) at Eglin Air Force Base, FL, Final Environmental Assessment*. Air Armament Center, 46 TW/XPE Range Environmental Planning Office, Eglin Air Force Base, Florida.

U.S. Air Force, 2005a. *Santa Rosa Island Mission Utilization Plan Programmatic Environmental Assessment*. Air Armament Center, 46 TW/XPE Range Environmental Planning Office, Eglin Air Force Base, Florida.

U.S. Air Force, 2005b. *Final Environmental Assessment for Eglin Gulf Test and Training Range (EGTTR) Precision Strike Weapons (PSW) Test (5-year plan) Eglin AFB, FL*. Air Armament Center, 46 TW/XPE Range Environmental Planning Office, Eglin Air Force Base, Florida.

U.S. Army Corps of Engineers (USACE), 2004a. *Water-borne Commerce of the United States, Calendar Year 2004. Part 5 - National Summaries*. Compiled under the supervision of the Institute for Water Resources U.S. Army Corps of Engineers Alexandria, Virginia. Retrieved from http://www.iwr.usace.army.mil/ndc/wcsc/pdf/wcusnatl04.pdf.

U.S. Army Corps of Engineers (USACE), 2004b. Tonnage for Selected U.S. Ports in 2004. Retrieved from www.iwr.usace.army.mil/NDC/wcsc/portname04.htm, on 5 January 2007.

U.S. Army Corps of Engineers (USACE), 2004c. South Carolina Port Environmental Impact Statement, Appendix L. Retrieved from http://www.porteis.com/project/documents.htm on 21 April, 2008.

U.S. Army Corps of Engineers (USACE), 2005. News Release: U.S. Navy Seeks Corps permit to perform work at Naval Submarine Base in New London, 1 February, 2005. Retrieved from http://www.nae.usace.army.mil/news/2005-12.htm, on 31 May 2007.

U.S. Army Corps of Engineers (USACE), 2006. *Final Environmental Impact Statement, Proposed Marine Container Terminal at the Charleston Naval Complex, North Charleston, South Carolina*. December.

U.S. Army Corps of Engineers (USACE), 2007a. Coastal Inlets Research Program, Frequently Asked Questions. Retrieved from http://cirp.wes.army.mil/cirp/FAQs/FAQ.html, on 26 June, 2007.

U.S. Army Corps of Engineers (USACE), 2007b. Dredging Information System. Retrieved from http://www.iwr.usace.army.mil/ndc/dredge/drgcorps.htm, on 26 June ,2007.

U.S. Army Corps of Engineers (USACE), 2007c. USACE Sea Turtle Data Warehouse, Norfolk District. Document obtained at http://el.erdc.usace.army.mil/seaturtles/info.cfm?Type=District&Code=NAO, on 31 May, 2007.

U.S. Army Corps of Engineers (USACE), 2007d. Record of Decision. Department of the Army Permit Application N. 2003-1T-016, South Carolina State Ports Authority's Proposed Marine Container Terminal at the Charleston Naval Complex, and Permit Application No. 2005-1N-440, South Carolina Department of Transportation's Proposed Port Access Roadway. South Carolina Port Environmental Impact Statement. April.

U.S. Army Corps of Engineers (USACE), 2007e. USACE Sea Turtle Data Warehouse, Jacksonville District. Retrieved from https://el.erdc.usace.army.mil/seaturtles/info.cfm?Type=District&Code=SAJ, on 31 May 2007.

U.S. Army, 2001. U.S. Army Research, Development, and Engineering Command, Aberdeen Proving Ground, Maryland. Corporate Information Office. Historical Research and Response Team. Off-shore Disposal of Chemical Agents and Weapons Condubted by the United States.

U.S. Coast Guard (USCG), 1999. Mandatory ship reporting systems. *Federal Register*, Vol 64, No104, pp 29229–29235.

U.S. Coast Guard (USCG), 2001. Mandatory ship reporting systems--Final rule. *Federal Register*, Vol 66, No 224, pp 58066–58070.

U.S. Coast Guard (USCG), 2005. Port access routes study of potential vessel routing measures to reduce vessel strikes of North Atlantic right whales--Notice of study. *Federal Register*, Vol 70, No 33, pp 8312–8314.

U.S. Coast Guard, 1994. Aids to Navigation (AtoN) Battery Release Reporting Requirements. Retrieved from at http://www.uscg.mil/ccs/cit/cim/directives/CI/CI_16478_10.pdf., on 25 May 1994.

U.S. Coral Reef Task Force, 2007a. Home page. Retrieved from http://www.coralreef.gov/, on 22 May 2007.

U.S. Coral Reef Task Force, 2007b. National Action Plan to Conserve Coral Reefs. Retreived from http://www.coralreef.gov/taskforce/nap/index.html, on 23 September 2007.

U. S. Department of Commerce and Department of the Navy (DOC and DON), 2001. *Joint Interim Report, Bahamas Marine Mammal Stranding Event of 15–16 March, 2000*. December.

U.S. Department of Energy (U.S. DOE), 2005. News Release: Company Plans Large Wind Plant Offshore of Galveston, Texas. 2 November 2005. Retreived from http://www.eere.energy.gov/states/

U.S. Environmental Protection Agency (EPA), 1998a. Guidelines for ecological risk assessment. *Federal Register*, Vol 63, No. 93, pp 26846–26924.

U.S. Environmental Protection Agency (EPA), 1998b. Study of Abyssal Seafloor Isolation of Contaminated Sediments Concluded. *Contaminated Sediment News*, No 22, Summer 1998.

U.S. Environmental Protection Agency (EPA), 2000. Project XL/ENVVEST: Naval Station Mayport. Document obtained at http://www.epa.gov/projctxl/mayport/mayportmay2000.pdf, on 31 May 2007.

U.S. Environmental Protection Agency (EPA), 2001. *Equilibrium Partitioning Sediment Guidelines (ESGs) for the Protection of Benthic Organisms: Metal Mixtures (Cadmium, Copper, Lead, Nickel, Silver and Zinc)*. EPA-822-R-00-005. EPA Office of Water. March 2001.

U.S. Environmental Protection Agency (EPA), 2002. Assessing and Monitoring Floatable Debris. August 2002.

U.S. Environmental Protection Agency (EPA), 2005. Marine Debris Factsheet, EPA-842-F-05-001i. October 2005.

U.S. Environmental Protection Agency (EPA), 2006. *National Recommended Aquatic Life Criteria*. Office of Water. Office of Science and Technology, 4304T. Retreived from http://www.epa.gov/waterscience/criteria/nrwqc-2006.pdf.

U.S. Environmental Protection Agency (EPA), 2007a. U.S. Coral Reef Task Force Habitat Protection. Retrieved from http://www.epa.gov/owow/oceans/coral/taskforce.html, on 22 May, 2007.

U.S. Environmental Protection Agency (EPA), 2007b. Ocean Regulatory Programs. Retrieved from http://www.epa.gov/owow/oceans/regulatory/index.html, on 22 May, 2007.

U.S. Environmental Protection Agency (EPA), 2007c. Ocean Dumping and Dredged Material Management. Retrieved from http://www.epa.gov/owow/oceans/regulatory/dumpdredged/dumpdredged.html, on 22 May, 2007.

U.S. Fish and Wildlife Service (USFWS) and National Marine Fisheries Service (NMFS), 1992. Recovery Plan for the Kemp’s Ridley Sea Turtle (*Lepidochelys kempii*). National Marine Fisheries Service, St. Petersburg, Florida. p 40.

U.S. Fish and Wildlife Service (USFWS), 1976. Determination of critical habitat for American crocodile, California condor, Indiana bat, and Florida manatee. *Federal Register*, Vol 41, No 187, pp 41914–41916.

U.S. Fish and Wildlife Service (USFWS), 2001a. Florida manatee recovery plan (*Trichechus manatus latirostris*), third revision. Atlanta, Georgia: U.S. Fish and Wildlife Service.

U.S. Fish and Wildlife Service (USFWS), 2001b. Nesting Loggerhead Sea Turtle Activity Report 2000 and 1980–2000 Nesting Summary. Prepared by S. Williams and J. Gallegos, Back Bay National Wildlife Refuge for the U.S. Army Corps of Engineers, Department of

U.S. Fish and Wildlife Service (USFWS), 2002a. Endangered and threatened wildlife and plants; manatee protection areas in Florida. *Federal Register*, Vol 67, No 4, pp 680–696.

U.S. Fish and Wildlife Service (USFWS), 2002b. Endangered and threatened wildlife and plants; emergency rule to establish seven additional manatee protection areas in Florida. *Federal Register*, Vol 67, No 183:59407–59426.

U.S. Fish and Wildlife Service (USFWS), 2002c. Endangered and threatened wildlife and plants; final rule to establish thirteen additional manatee protection areas in Florida; final rule to proposed rule. *Federal Register*, Vol 67, No 217, pp:68,449–68,489.

U.S. Fish and Wildlife Service (USFWS), 2007a. *2006 National Survey of Fishing, Hunting, and Wildlife-Associated Recreation National Overview*. May 2007.

U.S. Fish and Wildlife Service (USFWS), 2007b. Roseate Tern Habitat Model. Retrieved from http://www.fws.gov/r5gomp/gom/habitatstudy/metadata/roseate_tern_model.htm, on 24 July 2007.

U.S. Fish and Wildlife Service (USFWS), 2007c. Migratory Bird Permits; Take of Migratory Birds by the Armed Forces. Published in the *Federal Register*, Vol 72, No. 39 on 28 February 2007.

U.S. Fish and Wildlife Service (USFWS). 2005. *Report on the Mexico/United States of America population restoration project for the Kemp's ridley sea turtle,* Lepidochelys kempii*, on the coasts of Tamaulipas and Veracruz, Mexico, 2005*. Prepared for the USFWS by the Gladys Porter Zoo, Secretaria de Medio Ambiente y Recursos Naturales, and Secretaria de Obras Plblicas Desarrollo Urbano y Ecologia.

U.S. Fish and Wildlife Service (USFWS). 2007d. *West Indian Manatee (*Trichechus manatus*), 5-Year Review: Summary and Evaluation*. Prepared by the U.S. Fish and Wildlife Service, Southeast Region, Jacksonville Ecological Services Office Jacksonville, Florida. April.

U.S. Fish and Wildlife Service and National Marine Fisheries Service (USFWS and NMFS), 2003. *Endangered and Threatened Wildlife and Plants; Designation of Critical Habitat for the Gulf Sturgeon. Final Rule*. Effective 18 April 2003. Published in the *Federal Register*, Vol 68, No. 53 on 19 March 2003.

U.S. Food and Drug Administration, U.S. Department of Agriculture, and Centers for Disease Control and Prevention, 2001. *Draft assessment of the relative risk to public health from foodborne Listeria monocytogenes among selected categories of ready-to-eat foods.* Food and Drug Administration, Center for Food Safety and Applied Nutrition; U.S. Department of Agriculture, Food Safety and Inspection Service; and Centers for Disease Control and Prevention. Rockville, Maryland and Washington, D.C.

U.S. Geological Survey (USGS), 2001. Chessie the manatee on a comeback tour after 5-year hiatus. Accessed 7 August 2004. http://fl.water.usgs.gov/News/ChessieManatee.html.

U.S. Marine Corps, Department of the Navy (DON), and U.S. Air Force, 2003. *Amphibious Ready Group Marine Expeditionary Unit Training Readiness Training Environmental Assessment*. Air Armament Center, Eglin AFB, Florida.

Uchupi, E., and J. A. Austin, 1987. Morpology, in *Georges Bank*, R.H. Backus, ed. The MIT Press: Cambridge, Massachusetts. pp 26–30.

United Nations Atlas of the Oceans. Ocean Dumping and Ship Wastes, 2007. Retreived from http://www.oceansatlas.com/servlet/CDSServlet?status=ND0xODc2JmN0bl9pbmZvX3ZpZXdfc2l6ZT1jdG5faW5mb192aWV3X2Z1bGwmNj1lbiYzMz0qJjM3PWtvcw, on 9 January 2008.

University of South Florida, 2007. Fish Ultrasonic Hearing. Mann Laboratory, Marine Sensory Biology. Retrieved from http://www.marine.usf.edu/bio/fishlab/physiology.htm, on 22 June, 2007.

Urian, K. W., 1999. *Status of the Photo-Identification Catalog of Coastal Bottlenose Dolphins of the Western North Atlantic:* Report of a Workshop of Catalog Contributors.

Urian, K. W., D. A. Duffield, A. J. Read, R. S. Wells, and E. D. Shell, 1996. Seasonality of reproduction in bottlenose dolphins, *Tursiops truncatus*. *Journal of Mammalogy*, Vol 77, No 2, pp 394–403.

Urian, K. W., A. A. Hohn and L. J. Hansen, 1999. *Status of the photo–identification catalog of coastal bottlenose dolphins of the western North Atlantic: report of a workshop of catalog contributors. U.S. Department of Commerce, Beaufort, NC*. (NOAA Adminstrative Report NMFS-SEFSC-425) p 24. SH11 .A3441a no.425.

Urick, R. J., 1972. Noise signature of an aircraft in level flight over a hydrophone in the sea. *The Journal of the Acoustical Society of America,* Vol, No 3, pp 993–999.

Urick, R. J., 1983. *Principles of Underwater Sound, 3rd ed.* McGraw–Hill: New York.

Van Bree, P. J. H., 1996. Extralimital records of the Ringed Seal, Phoca hispida Schreber, 1775, on the West-European continental coast. *Bonner Zoologische Beitrage,* Vol 46, pp 377–383.

Van der Pol, B. A. E., J. G. F. Worst, and P. van Andel, 1995. Macro-anatomical aspects of the cetacean eye and its imaging system, in *Sensory Systems of Aquatic Mammals*, R. A. Kastelein, J. A. Thomas, and P. E. Nachtigall, eds. Woerden, The Netherlands: De Spil Publishers. pp 409–418.

Van Parijs, S. M., P. J. Corkeron, J. Harvey, S. A. Hayes, D. K. Mellinger, P. A. Rouget, P. M. Thompson, M. Wahlberg, and K. M. Kovacs, 2003. Patterns in the vocalizations of male harbor seals. *Journal of the Acoustical Society of America*, Vol 113, No 6, pp 3403–3410.

Van Waerebeek, K., F. Félix, B. Haase, D. M. Palacios, D. M. Mora-Pinto, and M. Muñoz-Hincapié, 1998. Inshore records of the striped dolphin, *Stenella coeruleoalba*, from the Pacific coast of South America. *Reports of the International Whaling Commission*, Vol 48, pp 525–532.

Van Waerebeek, K., J. C. Reyes, A. J. Read, and J. S. McKinnon, 1990. Preliminary observations of bottlenose dolphins from the Pacific coast of South America, in *The bottlenose Dolphin*, S. Leatherwood and R. R. Reeves, eds. Academic Press: San Diego, California. pp 143–154.

Vanderlaan, A. S. M., A. E. Hay, and C. T. Taggart, 2003. Characterization of North Atlantic right-whale (*Eubalaena glacialis*) sounds in the Bay of Fundy. IEEE *Journal of Oceanic Engineering*, Vol 28, pp 164–173.

Veirs, V., 2004. Source levels of free-ranging killer whale (*Orcinus orca*) social vocalizations. *Journal of the Acoustical Society of America*, Vol 116, 4, Part 2, pp 2615.

Verboom, W. C., and R. A. Kastelein, 1995a. Acoustic signals by harbour porpoises (*Phocoena phocoena*), in *Harbour Porpoises: Laboratory Studies to Reduce Bycatch*, P. E. Nachtigall, J. Lien, W. W. L. Au, and A. J. Read, eds..De Spil Publishers: Woerden, the Netherlands. pp 1–39.

Verboom, W. C., and R. A. Kastelein, 1995b. Rutting whistles of a male Pacific walrus (*Odobenus rosmarus divergens*). in *Sensory Systems of Aquatic Mammals*, R.A. Kastelein, J. A. Thomas, and P. E. Nachtigall, eds.De Spil Publishers: Woerden, The Netherlands. pp 287–298.

Verboom, W. C., and R. A. Kastelein, 2003. Structure of Harbor Porpoise (*Phocoena phocoena*) Acoustic Signals with High Repetition Rates in *Echolocation in Bats and Dolphins,* J.A. Thomas, C.F. Moss, and M. Vater, *e*ds.; The University of Chicago Press: Chicago and London.

Verdant Power, 2007. The RITE project: Roosevelt Island Tidal Energy Project, East River, New York. Retrieved from http://verdantpower.com/what-initiative, on 24 July 2007.

Verity, P. G., T. N. Lee, J. A. Yoder, G.A. Paffenhöfer, J.O. Blanton, and C.R. Alexander, 1993. Outer shelf processesin *Ocean Processes: U.S. Southeast Continental Shelf: A Summary of Research Conducted in the South Atlantic*, D.W. Menzel, ed. . pp 45–74.

Vester, H. I., 2003. *Do Arctic seals use echolocation?* Master's thesis, University of Tromsø.

Vester, H. I., L. P. Folkow, L. P. Blix, and A. Schytte, 2001. Underwater sound production from captive hooded and harp seals during live fish hunting, in *Abstracts, Fourteenth Biennial Conference on the Biology of Marine Mammals*. 28 November–3 December 2001. Vancouver, British Columbia. p 224.

Vidal, O., and J. P. Gallo-Reynoso, 1996. Die-offs of marine mammals and sea birds in the Gulf of California, Mexico. *Marine Mammal Science*, Vol 12, pp 627–635.

Villadsgaard, A., M. Wahlberg, and J. Tougaard, 2007. Echolocation signals of wild harbour porpoises, *Phocoena phocoena*. *The Journal of Experimental Biology*, Vol 210, pp 56–64.

Visser, I. N. and F. J. Bonoccorso, 2003. New observations and a review of killer whale (*Orcinus orca*) sightings in Papua New Guinea waters. *Aquatic Mammals*, Vol 29, No 1, pp 150–172.

Visser, I. N., 2005. First observations of feeding on thresher (*Alopias vulpinus*) and hammerhead (*Sphyrna zygaena*) sharks by killer whales (*Orcinus orca*) specialising on elasmobranch prey. *Aquatic Mammals*, Vol 31, No 1, pp 83–88.

Vukovich, F. M., 2005. *Climatology of Ocean Features in the Gulf of Mexico: Final Report*. U.S. Department of the Interior, Minerals Management Service, Gulf of Mexico OCS Region, New Orleans, Louisiana. OCS Study MMS 2005-031, p 58.

Wade, L. S., and G. L. Friedrichsen, 1979. Recent sightings of the blue whale, *Balenoptera musculus*, in the northeastern tropical Pacific. *Fishery Bulletin*, Vol 76, No 4, pp 915–919.

Wade, P. R., and T. Gerrodette, 1993. Estimates of cetacean abundance and distribution in the eastern tropical Pacific. *Reports of the International Whaling Commission*, Vol 43, pp 477–493.

Walker, N. D., 2001. *Wind and eddy related circulation on the Louisiana/Texas shelf and slope determined from satellite and in-situ measurements: October 1993–August 1994*. OCS Study MMS 2001-025. U.S . Department of the Interior, Minerals Mgmt. Service, Gulf of Mexico OCS Region, New Orleans, Louisiana. p 58.

Walker, W. A., 1981. *Geographical variation in morphology and biology of bottlenose dolphins (*Tursiops*) in the eastern North Pacific*. NMFS–SWFC Administrative Report LJ-81-03C:1-17.

Walsh, M. T., R. Y. Ewing, D. K. Odell, and G. D. Bossart, 2001. Mass strandings of cetaceans, in *Marine Mammal Medicine*, L. A. Dierauf and F. M. D. Gulland, eds. CRC Press: Boca Raton, Florida. pp 83–96.

Walther, G. R., E. Post, P. Convey, A. Menzel, C. Parmesan, R. J. C. Beebee, J. M. Fromentin, O. Hoegh-Guldberg and F. Bairlein, 2002. Ecological responses to recent climate change. *Nature,* Vol 416, pp 389–395.

Wang, K. R., P. M. Payne, and V. G. Thayer, compilers, 1994. *Coastal stock(s) of Atlantic bottlenose dolphin status review and management*. National Oceanic and Atmospheric Administration Technical Memorandum NMFS-OPR 4:1–120.

Wang, M. C., W. A. Walker, K. T. Shao, and L. S. Chou, 2003. Feeding habits of the pantropical spotted dolphin, *Stenella attenuata*, off the eastern coast of Taiwan. *Zoological Studies*, Vol 42, No 2, pp 368–378.

Wang, M. C., W.A. Walker, K. T. Shao, and L. S. Chou, 2002. Comparative analysis of the diets of pygmy sperm whales and dwarf sperm whales in Taiwanese waters. *Acta Zoologica Taiwanica*, Vol 13, No 2, pp 53–62.

Waples, R. and P. Clapham, eds., 2004. *Report of the working group on killer whales as a case study*. in *Report of the Workshop on Shortcomings of Cetacean Taxonomy in Relation to Needs of Conservation and Management: April 30 – May 2, 2004, La Jolla, California*, Reeves, R.R., W.F. Perrin, B.L. Taylor, C.S. Baker, and S.L. Mesnick, eds.. NOAA Technical Memorandum NMFS-SWFSC-363. pp 62–73.

Ward, J. A., 1999. *Right whale (*Balaena glacialis*) South Atlantic Bight habitat characterization and prediction using remotely sensed oceanographic data*. Master's thesis, University of Rhode Island.

Ward, J. A., G. Mitchell, A. Farak, E. Keane, and McLaughlin Research Corporation, 2004. *Beaked whale habitat characterization and prediction*. Navy Technical Report. Newport, Rhode Island: Naval Underwater Warfare Center.

Ward, J. A., G. H. Mitchell, A. M. Farak, and E. P. Keane, 2005. *Beaked whale habitat characterization and prediction*. NUWC-NPT Technical Report 11,548. Newport, Rhode Island: Naval Undersea Warfare Center Division.

Ward, W. D., 1960. Recovery from high values of temporary threshold shift. *Journal of the Acoustical Society of America*, Vol 32, pp 497–500.

Ward, W. D., 1997. Effects of high-intensity sound, in *Encyclopedia of Acoustics*, ed. M.J. Crocker. Wiley: New York. pp 1497–1507.

Ward, W. D., A. Glorig, and D. L. Sklar, 1958. Dependence of temporary threshold shift at 4 kc on intensity and time. *Journal of the Acoustical Society of America*, Vol 30, pp 944–954.

Ward, W. D., A. Glorig, and D. L. Sklar, 1959. Temporary threshold shift from octave-band noise: Applications to damage-risk criteria. *Journal of the Acoustical Society of America*, Vol 31, pp 522–528.

Ward-Geiger, L. I., G. K. Silber, R. D. Baumstark, and T. L. Pulfer, 2005. Characterization of ship traffic in right whale critical habitat. *Coastal Management*, Vol 33, pp 263–278.

Ware, C., R. Arsenault, M. Plumlee, and D. Wiley, 2006. Visualizing the underwater behavior of humpback whales. *IEEE Computer Graphics and Applications*, Vol 26, No 4, pp 14–18.

Waring G. T., E. Josephson, C. P. Fairfield-Walsh, and K. Maze-Foley. 2008. *US Atlantic and Gulf of Mexico Marine Mammal Stock Assessments – 2007*. U.S. Department of Commerce. National Oceanic and Atmospheric Administration, National Marine Fisheries Service, Northeast Fisheries Science Center. NOAA Technical Memorandum NMFS-NE-205. Woods Hole. January.

Waring, G. T., and J. T. Finn, 1995. Cetacean trophic interactions off the northeast USA inferred from spatial and temporal co-distribution patterns. Unpublished meeting document. ICES C.M. 1995/N:7:1-44. Copenhagen, Denmark: International Council for the Exploration of the Sea.

Waring, G. T., and D. L. Palka, 2002. North Atlantic marine mammals, in *Encyclopedia of Marine Mammals*, W.F. Perrin, B. Würsig, and J. G. M. Thewissen, eds. Academic Press: San Diego. pp 802–806.

Waring, G. T., C. P. Fairfield, C. M. Ruhsam, and M. Sano, 1992. *Cetaceans associated with Gulf Stream features off the northeastern USA Shelf*. Unpublished meeting document, ICES C.M. 1992/N:12. Copenhagen: International Council for the Exploration of the Sea.

Waring, G. T., C. P. Fairfield, C. M. Ruhsam, and M. Sano, 1993. Sperm whales associated with Gulf Stream features off the northeastern USA shelf. Fishery *Oceanography*, Vol 2, No 1, p 105.

Waring, G. T., E. Josephson, C. P. Fairfield, and K. Maze-Foley, eds., 2006. *U.S. Atlantic and Gulf of Mexico Marine Mammal Stock Assessments -- 2005.* NOAA Technical Memorandum NMFS-NE-194:1-346.

Waring, G. T., E. Josephson, C. P. Fairfield, and K.Woodings, S., 1995. *A plausible physical cause of mass cetacean strandings*, Honours Thesis, Supervisor, RN James, Department of Physics, University of Western Australia.

Waring, G. T., E. Josephson, C. P. Fairfield, K. Maze-Foley, eds., 2007. *U.S. Atlantic and Gulf of Mexico Marine Mammal Stock Assessments—2006*. NOAA Technical Memorandum, NMFS-NE-201. April 2007.

Waring, G. T., J. M. Quintal, and C. P. Fairfield, eds., 2002. *U.S. Atlantic and Gulf of Mexico marine mammal stock assessments – 2002*. NOAA Technical Memorandum NMFS-NE-169.

Waring, G. T., J. M. Quintal, and S. L. Swartz, eds., 2000. *U.S. Atlantic and Gulf of Mexico marine mammal stock assessments–2000*. NOAA Technical Memorandum NMFS-NE 162:1–300.

Waring, G. T., P. Gerrior, P. M. Payne, B. L. Parry, and J. R. Nicolas, 1990. Incidental take of marine mammals in foreign fishery activities off the northeast United States, 1977-88. *Fishery Bulletin*, Vol 88, No 2, pp 347–360.

Waring, G. T., R. M. Pace, J. M. Quintal, C. P. Fairfield, and K. Maze-Foley, eds. 2004. *U.S. Atlantic and Gulf of Mexico marine mammal stock assessments – 2003*. NOAA Technical Memorandum NMFS-NE-182:1–287.

Waring, G. T., T. Hamazaki, D. Sheehan, G. Wood, and S. Baker, 2001. Characterization of beaked whale (Ziphiidae) and sperm whale (*Physeter macrocephalus*) summer habitat in shelf-edge and deeper waters off the northeast U.S. *Marine Mammal Science*, Vol 17, No 4, pp 703–717.

Waring, G., D. Belden, M. Vecchione, and R. Gibbons, 2003. Mid-water prey in beaked whale and sperm whale deep-water habitat south of Georges Bank, in *Abstracts, Fifteenth Biennial Conference on the Biology of Marine Mammals*. 14–19 December 2003. Greensboro, North Carolina. p 172.

Wartzok, D. and D. R. Ketten, 1999. Marine mammal sensory systems, in *Biology of Marine Mammals*, J. E. Reynolds III and S. A. Rommel, eds.. Smithsonian Institution Press: Washington, D.C. pp 117–175.

Wartzok, D., A. N. Popper, J. Gordon, and J. Merrill, 2003. Factors affecting the responses of marine mammals to acoustic disturbance. *Marine Technology Society Journal*, Vol 37, No 4, pp 6–15.

Washington Post, 2006. Offshore Wind Farm is Approved; Plant Off Texas Coast to be Biggest of Its Kind in U.S. 12 May 2006. Document obtained at http://www.washingtonpost.com/wp-dyn/content/article/2006/05/11/AR2006051101967.html, on 21 May 2007.

Washington Post, 2008. House Democrats to Let Ban on Drilling Expire; Senate Approves $100 Billion Tax Break. September 24, 2008, pg A2.

Waterbird Conservation for the Americas, 2007a. Retrieved from http://www.waterbirdconservation.org/, on 26 June 2007.

Waters, J. H., 1967. Gray seal remains from southern New England archeological sites. *Journal of Mammalogy*, Vol 48, pp 139–141.

Watkins, W. A., and W. E. Schevill, 1976. Right whale feeding and baleen rattle. *Journal of Mammalogy*, Vol 57, pp 58–66.

Watkins, W. A., and W. E. Schevill, 1977. Sperm whale codas. *Journal of the Acoustical Society of America*, Vol 62, No 6, pp 1485–1490.

Watkins, W. A., and W. E. Schevill, 1979. Aerial observation of feeding behavior in four baleen whales: *Eubalaena glacialis*, *Balaenoptera borealis*, *Megaptera novaeangliae*, and *Balaenoptera physalus*. *Journal of Mammalogy*, Vol 60, No 1, pp 155–163.

Watkins, W. A., M. A. Daher, A. Samuels, and D. P. Gannon, 1997. Observations of *Peponocephala electra*, the melon-headed whale, in the southeastern Caribbean. *Caribbean Journal of Science*, Vol 33, No 1, pp 34–40.

Watkins, W. A., M. A. Daher, J. E. George, and S. Haga, 2000. *Distribution of calling blue, fin, and humpback whales in the North Pacific.* Technical Report WHOI-00-12. Woods Hole Oceanographic Institution: Woods Hole, Massachusetts.

Watkins, W. A., M. A. Daher, K. Fristrup, and G. Notarbartolo di Sciara, 1994. Fishing and acoustic behavior of Fraser's dolphin (*Lagenodelphis hosei*) near Dominica, southeast Caribbean. *Caribbean Journal of Science*, Vol 30, No 1, pp 76–82.

Watkins, W. A., M. A. Daher, K. M. Fristrup, T. J. Howald, and G. Notarbartolo di Sciara, 1993. Sperm whales tagged with transponders and tracked underwater by sonar. *Marine Mammal Science*, Vol 9, No 1, pp 55–67.

Watkins, W. A., M. A. Daher, N. A. DiMarzio, A. Samuels, D. Wartzok, K. M. Fristrup, P. W. Howey, and R. R. Maiefski, 2002. Sperm whale dives tracked by radio tag telemetry. *Marine Mammal Science*, Vol 18, No 1, pp 55–68.

Watkins, W. A., P. Tyack, K. E. Moore, and J. E. Bird, 1987. The 20-Hz signals of finback whales (*Balaenoptera physalus*). *Journal of the Acoustical Society of America*, Vol 82, No 6, pp 1901–1912.

Watts, P. and D. E. Gaskin, 1985a. Habitat index analysis of the harbor porpoise (*Phocoena phocoena*) in the southern coastal Bay of Fundy, Canada. *Journal of Mammalogy*, Vol 66, pp 733–744.

Watts, P., and D .E. Gaskin, 1985b. Habitat index analysis of the harbor porpoise (*Phocoena phocoena*) in the southern coastal Bay of Fundy, Canada. *Canadian Journal of Zoology*, Vol 61, pp 126–132.

Watwood, S. L., P. J. O. Miller, M. Johnson, P. T. Madsen, and P. L. Tyack, 2006. Deep-diving foraging behaviour of sperm whales *(Physeter macrocephalus)*. *Journal of Animal Ecology*, Vol 75, pp 814–825.

Weaver's Cove Energy, 2005. Weaver's Cove Energy Proposal. Retrieved from http://www.weaverscove.com/proposal-about.html#, on 17 October, 2007.

Webb, J. F., J. Montgomery, and J. Mogdans, 2008. Bioacoustics and the lateral line of fishes. In *Fish Bioacoustics*, eds. J. F. Webb, R. R. Fay, and A. N. Popper. New York: Springer Science, Business Media, LLC.

Weber, M., 1995. Kemp's ridley sea turtle, *Lepidochelys kempii*. Pages 109–122 in P.T. Plotkin, ed. Status reviews of sea turtles listed under the Endangered Species Act of 1973. Silver Spring, Maryland: National Marine Fisheries Service.

Webster, W. D., and K. A. Cook. 2001. Intraseasonal nesting activity of loggerhead sea turtles (*Caretta caretta*) in southeastern North Carolina. *American Midland Naturalist*, Vol 145, pp 66–73.

Webster, W. D., P. D. Goley, J. Pustis, and J. F. Gouveia, 1995. Seasonality in cetacean strandings along the coast of North Carolina. *Brimleyana*, Vol 23, pp 41–51.

Wedekin, L. L., A. Freitas, M. H. Engel, and I. Sazima, 2004. Rough-toothed dolphins (*Steno bredanensis*) catch diskfishes while interacting with humpback whales (*Megaptera novaeangliae*) off Abrolhos Bank breeding ground, southwest Atlantic. *Aquatic Mammals*, Vol 30, No 2, pp 327–329.

Weilgart, L. and H. Whitehead, 1997. Group-specific dialects and geographical variation in coda repertoire in South Pacific sperm whales. *Behavioral Ecology and Sociobiology*, Vol 40, pp 277–285.

Weinrich, M. T. and A. E. Kuhlberg, 1991. Short-term associations of humpback whale (*Megaptera novaeangliae*) groups on their feeding grounds in the southern Gulf of Maine. *Canadian Journal of Zoology*, Vol 69, pp 3005–3011.

Weinrich, M. T., C.R. Belt, and D. Morin, 2001. Behavior and ecology of the Atlantic white-sided dolphin (*Lagenorhynchus acutus*) in coastal New England waters. *Marine Mammal Science*, Vol 17, pp 231–248.

Weinrich, M. T., M. R. Schilling, and C. R. Belt, 1992. Evidence for acquisition of a novel feeding behaviour: Lobtail feeding in humpback whales, *Megaptera novaeangliae*. *Animal Behaviour*, Vol 44, pp 1059–1072.

Weinrich, M., 1995. Humpback whale competitive groups observed on a high-latitude feeding ground. *Marine Mammal Science*, Vol 11, No 2, pp 251–254.

Weinrich, M., 1998. Early experience in habitat choice by humpback whales (*Megaptera novaeangliae*). *Journal of Mammalogy*, Vol 79, No 1, pp 163–170.

Weinrich, M., M. Martin, R. Griffiths, J. Bove, and M. Schilling, 1997. A shift in distribution of humpback whales, *Megaptera novaeangliae*, in response to prey in the southern Gulf of Maine. *Fishery Bulletin*, Vol 95, No 4, pp 826–836.

Weinrich, M. T., R. D. Kenney, and P. K. Hamilton, 2000. Right whales (*Eubalaena glacialis*) on Jeffreys Ledge: A habitat of unrecognized importance? *Marine Mammal Science*, Vol 16, No 2, pp 326–337.

Weir, C. R., 2003. Sperm whale (*Physeter macrocephalus*) codas in the northern Gulf of Mexico: Repertoire, structure and usage. Master's thesis, University of Wales, Bangor.

Weir, C. R., J. Stokes, C. Martin, and P. Cermeño, 2004. Three sightings of *Mesoplodon* species in the Bay of Biscay: First confirmed True's beaked whales (*M. mirus*) for the north–east Atlantic? *Journal of the Marine Biological Association of the United Kingdom*, Vol 84, pp 1095–1099.

Weisman, R., 2007. State gets $2m grant for wind technology. *The Boston Globe*. Retrieved from http://www.boston.com/business/technology/articles/2007/06/26/state_gets_2m_grant_for_wind_technology, on 27 June 2007.

Weller, D. W., A. J. Schiro, V. G. Cockcroft, and W. Ding, 1996a. First account of a humpback whale (*Megaptera novaeangliae*) in Texas waters, with a re-evaluation of historical records from the Gulf of Mexico. *Marine Mammal Science*, Vol 12, No 1, pp 133–137.

Weller, D. W., B. Würsig, S. K. Lynn, and A.J. Schiro, 2000. Preliminary findings on the occurrence and site fidelity of photo-identified sperm whales (*Physeter macrocephalus*) in the northern Gulf of Mexico. *Gulf of Mexico Science*, Vol 18, No 1, pp 35–39.

Weller, D. W., B. Würsig, H. Whitehead, J.cC. Norris, S. K. Lynn, R. W. Davis, N. Clauss, and P. Brown, 1996b. Observations of an interaction between sperm whales and short-finned pilot whales in the Gulf of Mexico. *Marine Mammal Science*, Vol 12, No 4, pp 588–594.

Wells, R. S. and J. Gannon, 2006. Follow-up monitoring of rehabilitated rough-toothed dolphins. Retreived from http://www.sarasotadolphin.org/DolphinRescues/roughtooth2006.asp, on 26 January 2007.

Wells, R. S. and M. D. Scott, 1999. Bottlenose dolphin--*Tursiops truncatus* (Montagu, 1821), in *Handbook of Marine Mammals, Vol 6: The Second Book of Dolphins and the Porpoises*, S. H. Ridgway, and R. Harrison, eds.Academic Press: San Diego, California. pp 137–182.

Wells, R. S., A. B. Irvine, and M. D. Scott, 1980. The social ecology of inshore odontocetes. in *Cetacean Behavior: Mechanisms and Functions*, L. M. Herman, ed. John Wiley: New York. pp 263–318.

Wells, R. S., H. L. Rhinehart, P. Cunningham, J. Whaley, M. Baran, C. Koberna, and D. P. Costa, 1999. Long distance offshore movements of bottlenose dolphins. *Marine Mammal Science*, Vol 15, No 4, pp 1098–1114.

Wells, R. S., L. J. Hansen, A. Baldridge, T. P. Dohl, D. L. Kelly, and R. H. Defran, 1990. Northward extension of the range of bottlenose dolphins along the California coast, in *The bottlenose Dolphin*, S. Leatherwood and R. R. Reeves, eds. Academic Press: San Diego. pp 421–431.

Wells, R. S., M. D. Scott, and A. B. Irvine, 1987. The social structure of free-ranging bottlenose dolphins, in *Current Mammalogy, Volume 1*, H. H. Genoways, ed. John Wiley & Sons: New York:. pp 247–305.

Wells, R., 2007. Personal communication via email between Dr. Randall Wells, Mote Marine Laboratory, Sarasota, Florida, and Ms. Dagmar Fertl, Geo-Marine, Inc., Plano, Texas, 29 January.

Wells, R., C. Mainire, H. Rhinehart, D. Smith, A. Westgate, F. Townsend, T. Rowles, A. Hohn, and L. Hansen, 1999. Ranging patterns of rehabilitated rough-toothed dolphins, *Steno bredanensis*, released in the northeastern Gulf of Mexico, in *Abstracts*, *Thirteenth Biennial Conference on the Biology of Marine Mammals.* 28 November-3 December, 1999. Wailea, Hawaii. p 199.

Wenz, G. M., 1962. Acoustic ambient noise in the ocean: Spectra and sources. *Journal of the Acoustical Society of America*, Vol 34, No 12, pp 1936–1956. December.

Wenzel, F., D. K. Mattila, and P. J. Clapham, 1988. *Balaenoptera musculus* in the Gulf of Maine. *Marine Mammal Science*, Vol 4, No 1, pp –175.

Weslawski, J. M., M. Ryg, T.G. Smith, and N.A. Oritsland, 1994. Diet of ringed seals (*Phoca hispida*) in a fjord of west Svalbard. *Arctic*, Vol 47, No 2, pp 109–114.

Westgate, A. J., A. J. Read, P. Berggen, H. N. Koopman, and D. E. Gaskin, 1995. Diving behaviour of harbour porpoises, *Phocoena phocoena*. *Canadian Journal of Fisheries and Aquatic Sciences*, Vol 52, pp 1064–1073.

Westgate, A. J., A. J. Read, T. M. Cox, T. D. Schofield, B. R. Whitaker, and K. E. Anderson, 1998. Monitoring a rehabilitated harbor porpoise using satellite telemetry. *Marine Mammal Science*, Vol 14, No 3, pp 599–604.

Westgate, A. J., and A. J. Read, 1998. The application of new technology to the conservation of porpoises. *Marine Technology Society Journal*, Vol 32, pp 70–81.

Wever, E. G., 1978. *The Reptile Ear—Its Structure and Function*. Princeton University Press.

Whale and Dolphin Conservation Society (WDCS), 2007. Whale Watching in New England. Retrieved from http://www.whales.org/whale_watching.asp, on 25 June 2007.

Whale Center of New England, 2007. Whale, Dolphin and Seal Species Information. Retrieved from http://www.whalecenter.org/species.htm, on 15 June 2007.

WhaleNet, 1998. Metompkin's movements. Accessed April 2001. http://whale.wheelock.edu/whalenet-stuff/stop_data.html.

WhaleNet, 2003a. Harbor porpoise, Duke University Marine Lab: Owen's movements.. http://whale.wheelock.edu/whalenet-stuff/stopTab/Hpdata_Tab.html, on 24 March, 2004

WhaleNet, 2003b. Tom and Nikkie Gray Seal; Satellite Tagging Observation Reports. Retrieve from April 2007. http://whale.wheelock.edu/whalenet-stuff/StopUNE03/reportsUNE.html.

WhaleNet, 2004. Coordinates of satellite tag attached to harbor porpoise "Gus". Retreived from http://whale.wheelock.edu/whalenet-stuff/StopUNE04Hp/data_Gus.html., on 18 April, 2006.

WhaleNet, 2005. Coordinates of satellite tag attached to Risso's dolphin "Rocky". Retreived from http://whale.wheelock.edu/whalenet-stuff/Stop47826/data47826.html., on 18 April, 2006.

WhaleNet, 2006. Kitty Harbor Seal ; Satellite Tagging Observation Reports. Retrieved from http://whale.wheelock.edu/whalenet-stuff/Stop47822/reports47822.html., on April 2007.

White House, 2008. Fact Sheet: Allowing Offshore Exploration to Help Address Rising Fuel Costs. July 14, 2008.

Whitehead, H. and J. E. Carscadden, 1985. Predicting inshore whale abundance - Whales and capelin off the Newfoundland coast. *Canadian Journal of Fisheries and Aquatic Sciences*, Vol 42, pp 976–981.

Whitehead, H. and L. Weilgart, 1991. Patterns of visually observable behaviour and vocalizations in groups of female sperm whales. *Behaviour*, Vol 118, pp 276–296.

Whitehead, H. and L. Weilgart, 2000. The sperm whale: Social females and roving males, in *Cetacean Societies, Field Studies of Dolphins and Whales*, J. Mann, R. C. Connor, P. L. Tyack, and H. Whitehead, eds. University of Chicago Press: Chicago, Illinois. pp 154–172.

Whitehead, H., and M. J. Moore, 1982. Distribution and movements of West Indian humpback whales in winter. *Canadian Journal of Zoology*, Vol 60, pp 2203–2211.

Whitehead, H., 1982. Populations of humpback whales in the northwest Atlantic. *Reports of the International Whaling Commission* , Vol 32, pp 345–353.

Whitehead, H., 2003. *Sperm Whales: Social Evolution in the Ocean*. University of Chicago Press: Chicago.

Whitehead, H., A. Faucher, S. Gowans, and S. McCarrey, 1997. Status of the northern bottlenose whale, *Hyperoodon ampullatus*, in the Gully, Nova Scotia. *Canadian Field-Naturalist*, Vol 111, No 2, pp 287–292.

Whitehead, H., S. Brennan, and D. Grover, 1992. Distribution and behaviour of male sperm whales on the Scotian Shelf, Canada. *Canadian Journal of Zoology*, Vol 70, pp 912–918.

Whitman, A. A., and P. M. Payne, 1990. Age of harbour seals, *Phoca vitulina concolor*, wintering in southern New England. *Canadian Field-Naturalist*, Vol 104, No 4, pp 579–582.

Wiebe, P., R. Beardsley, D. Mountain, and A. Bucklin, 2002. U.S. Globec Northwest Atlantic/Georges Bank Program. *Oceanography*, Vol 15, No 2, pp 13–29.

Wiley, D. N., F. W. Wenzel, and S. B. Young, 1994. Extralimital residency of bottlenose dolphins in the western North Atlantic. *Marine Mammal Science*, Vol 10, No 2, pp 223–226.

Wiley, D. N., G. Early, C. A. Mayo, and M. J. Moore, 2001. Rescue and release of mass stranded cetaceans from beaches on Cape Cod, Massachusetts, USA; 1990–1999: A review of some response actions. *Aquatic Mammals*, Vol 27, No 2, pp 162–171.

Wiley, D. N., J. C. Moller, and K. A. Zilinskas, 2003. The distribution and density of commercial fisheries and baleen whales within the Stellwagen Bank National Marine Sanctuary: July 2001-June 2002. *Marine Technology Society Journal*, Vol 37, No 1, pp 35–53.

Wiley, D. N., T. D. Pitchford, and D. P. Gannon, 1995. Stranding and Mortality of Humpback Whales, Megaptera novaeangliae, in the Mid-Atlantic and Southeast United States, 1985–1992. *Fishery Bulletin*, Vol 93, pp 196–205.

Wiley, R. H., and D. S. Lee, 1999. Parasitic Jaeger (*Stercorarius parasiticus*), in *The Birds of North America, No. 445*, A. Poole and F. Gill, eds. The Birds of North America, Inc.: Philadelphia, PA.

Wilkinson, D. M., 1991. *Report to the Assistant Administrator for Fisheries, in Program Review of the Marine Mammal Stranding Networks.* U.S. Department of Commerce, NOAA, National Marine Fisheries Service: Silver Springs, Maryland. pp 1–171.

Williams, A. B., L. G. Abele, D. L. Felder, H. H. Hobbs, R. B. Manning, P. A. McLaughlin, and I. P. Farfante, 1989. Common and scientific names of aquatic invertebrates from the United States and Canada: decapod crustaceans. *American Fisheries Society Special Publication*, Vol 17, pp 1–77.

Williams, A. D., R. Williams, and T. Brereton, 2002. The sighting of pygmy killer whales (*Feresa attenuata*) in the southern Bay of Biscay and their association with cetacean calves. *Journal of the Marine Biological Association of the U.K.*, Vol 82, pp 509–511.

Willis, P. M., and R. W. Baird, 1998. Status of the dwarf sperm whale, *Kogia simus*, with special reference to Canada. *Canadian Field-Naturalist*, Vol 112, No 1, pp 114–125.

Wilson, B., and L. M. Dill, 2002. Herring respond to simulated odontocete echolocation sounds. *Canadian Journal of Fisheries and Aquatic Science*, Vol 59, pp 543–553.

Wilson, M., R. T. Hanlon, P. L. Tyack, and P. T. Madsen, 2007. Intense ultrasonic clicks from echolocating toothed whales do not elicit anti-predator responses or debilitate the squid *Loligo pealeii*. *Biology Letters*, Vol 3, pp 225–227.

Wilson, S. C., 1978. Social organization and behavior of harbor seals, *Phoca concolor*, in Maine. Final report to the Marine Mammal Commission. Contract MM6AC013, GPO-PB-280-188.

Wingfield, J. C., 2003. Control of behavioural strategies for capricious environments. Animal Behavior, Vol 66, No 5, pp 807–816(10).

Winn, H. E. and P. J. Perkins, 1976. Distribution and sounds of the minke whale, with a review of mysticete sounds. *Cetology*, Vol 19, pp 1–12.

Winn, H. E., C. A. Price, and P. W. Sorensen, 1986. The distributional biology of the right whale (*Eubalaena glacialis*) in the western North Atlantic. *Reports of the International Whaling Commission*, Special Issue 10, pp 129–138.

Winn, H. E., J. D. Goodyear, R. D. Kenney, and R.O. Petricig, 1995. Dive patterns of tagged right whales in the Great South Channel. *Continental Shelf Research*, Vol 15, pp 593–611.

Winn, H. E., P. J. Perkins, and L. Winn, 1970. Sounds and behavior of the northern bottle-nosed whale, in *Proceedings, Seventh Annual Conference on Biological Sonar and Diving Mammals*. Menlo Park, California. pp 53–59.

Winn, L. K., H. E. Winn, D. K. Caldwell, M. C. Caldwell, and J. L. Dunn, 1979. Marine mammals. in *CNA (Center for Natural Areas), ed*. A summary and analysis of environmental information on the continental shelf and Blake Plateau from Cape Hatteras to Cape Canaveral (1977). Vol 1, Bk 2. Washington, D.C.: Bureau of Land Management. pp 1–117.

Wishner, K., E. Durbin, A. Durbin, M. Macaulay, H. Winn, and R. Kenney, 1988. Copepod patches and right whales in the Great South Channel off New England. *Bulletin of Marine Science*, Vol 43, pp 825–844.

Wiss, M., 2006. USS Georgia: It's Official! *Kings Bay Periscope*. Retrieved from http://www.kingsbay periscope.com/stories/080306/kin_georgia.shtml, on 14 August 2006.

Witham, R., 1980. The "lost year" question in young sea turtles. *American Zoologist*, Vol 20, No 3, pp 525–530.

Witherington, B. E., 1994a. Flotsam, jetsam, post-hatchling loggerheads, and the advecting surface smorgasbord. in *Proceedings of the Fourteenth Annual Symposium on Sea Turtle Biology and Conservation*, K. A. Bjorndal, A. B. Bolten, D. A. Johnson, and P. J. Eliazar, eds. NOAA Technical Memorandum NMFS-SEFSC-351. pp 166–168.

Witzell, W. N., and W. G. Teas, 1994. *The impacts of anthropogenic debris on marine turtles in the western North Atlantic Ocean*. NOAA Technical Memorandum, NMFS-SEFSC-355, 21 pp.

Witzell, W. N., 1983. *Synopsis of the Biological Data on the Hawksbill Turtle* Eretmochelys imbricata *(Linnaeus 1766*). Food and Agriculture Organization Fisheries Synopsis Number 137. Food and Agriculture Organization, Rome. p 78.

Wolfson, A., G. Thomas, and C. Leslie, 2008. *Essential fish habitat assessment for Navy Atlantic Fleet training in the Jacksonville Range Complex. Environmental Impact Statement/Overseas Environmental Impact Statement*, Appendix F. Prepared for the U.S. Navy. Prepared by Q & S Engineering, Inc. in Association with Parsons. May 2008.

Wolski, L. F., R. C. Anderson, A.E. Bowles, and P.K. Yochem, 2003. Measuring hearing in the harbor seal (*Phoca vitulina*): Comparison of behavioral and auditory brainstem response techniques. *Journal of the Acoustical Society of America*, Vol 113, pp 629–637.

Wood, S., A. Ferland, G.T. Waring, L. Sette, and S. Shaw, 2001. Harbor seal (*Phoca vitulina*) food habits along the New England coast, in *Abstracts, Fourteenth Biennial Conference on the Biology of Marine Mammals*. November 28 – December 3 2001. Vancouver, British Columbia. pp 236-237.

Wood, S., V. Rough, J. Gilbert, G. Waring, and S. Brault, 2003. The current status of gray seals (*Halichoerus grypus*) in the United States, in *Abstracts, Fifteenth Biennial Conference on the Biology of Marine Mammals*. 14–19 December 2003. Greensboro, North Carolina. p 180.

Woodley, T. H. and D. E. Gaskin, 1996. Environmental characteristics of North Atlantic right and fin whale habitat in the lower Bay of Fundy, Canada. *Canadian Journal of Zoology*, Vol 74, pp 75–84.

Wormuth, J. H., P. H. Ressler, R. B. Cady, and E. J. Harris, 2000. Zooplankton and micronekton in cyclones and anticyclones in the northeast Gulf of Mexico. *Gulf of Mexico Science*, Vol 18, No 1, pp 23–34.

Wright, B. S., 1951. A walrus in the Bay of Fundy; the first record. *Canadian Field–Naturalist*, Vol 65, pp 61–64.

Wright, K. J., D. M. Higgs, A. J. Belanger, and J. M. Leis, 2005. Auditory and olfactory abilities of pre-settlement larvae and post-settlement juveniles of a coral reef damselfish (Pisces:Pomacentridae). *Marine Biology*, Vol 147, pp 1425–1434, or pp 1049–1050.

Würsig, B., and T. A. Jefferson, 1990. Methods of photo-identification for small cetaceans. *Reports of the International Whaling Commission*, Special Issue 12, pp 43–52.

Würsig, B., and M. Würsig, 1977. The photographic determination of group size, composition, and stability of coastal porpoises (*Tursiops truncatus*). *Science*, Vol 198, pp 755–756.

Würsig, B., R. R. Reeves, and J. G. Ortega-Ortiz, 2002. Global climate change and marine mammals, in *Marine Mammals: Biology and Conservation*, P.G.H. Evans and J.A. Raga, eds. Kluwer Academic/Plenum Publishers: New York. pp 589–608.

Würsig, B., S. K. Lynn, T. A. Jefferson, and K. D. Mullin, 1998. Behaviour of cetaceans in the northern Gulf of Mexico relative to survey ships and aircraft. *Aquatic Mammals*, Vol 24, No 1, pp 41–50.

Würsig, B., T. A. Jefferson, and D. J. Schmidly, 2000. *The Marine Mammals of the Gulf of Mexico*. Texas A&M University Press: College Station.

Wynne, K., and M. Schwartz, 1999. *Guide to Marine Mammals & Turtles of the U.S. Atlantic & Gulf of Mexico*. Narragansett: Rhode Island Sea Grant.

Wysocki, L. E., and F. Ladich, 2005. Hearing in fishes under noise conditions. *Journal of the Association for Research in Otoryngology*, Vol 6, No 1, pp 28–36.

Yazvenko, S. B., T. L. McDonald, S. A. Blokhin, S. R. Johnson, H. R. Melton, M. W. Newcomer, R. Nielson, and P. W. Wainwright, 2007. Feeding of western grey whales during a seismic survey near Sakhalin Island, Russia. *Environmental Monitoring and Assessment*, Vol 134, pp 93–106.

Yochem, P. K., and S. Leatherwood, 1985. Blue whale *Balaenoptera musculus* (Linnaeus, 1758), in *Handbook of Marine Mammals, Vol 3: The Sirenians and Baleen Whales*, S. H. Ridgway and R. Harrison, eds.Academic Press: San Diego, California. pp 193–240.

Yoshida, H., and H. Kato, 1999. Phylogenetic relationships of Bryde's whales in the western North Pacific and adjacent waters inferred from mitochondrial DNA sequences. *Marine Mammal Science*, Vol 15, No 4, pp 1269–1286.

Yost, W. A., 1994. *Fundamentals of Hearing: An Introduction*. Academic Press: San Diego.

Young, D. D., and V. G. Cockcroft, 1994. Diet of common dolphins (*Delphinus delphis*) off the south-east coast of southern Africa: Opportunism or specialization? *Journal of Zoology, London*, Vol 234, pp 41–53.

Yu, H.-y., H. K. Mok, R. C. Wei, and L. S. Chou, 2003. Vocalizations of a rehabilitated rough-toothed dolphin, *Steno bredanensis*, in *Abstracts, Fifteenth Biennial Conference on the Biology of Marine Mammals*. 14-19 December, 2003. Greensboro, North Carolina. pp 183.

Yuen, M. M. L., P. E. Nachtigall, M. Breese, and A.Y. Supin, 2005. Behavioral and auditory evoked potential audiograms of a false killer whale (*Pseudorca crassidens*). *Journal of the Acoustical Society of America*, Vol 118, No 4, pp 2688–2695.

Yurk, H., L. Barrett-Lennard, J. K. B. Ford, and C. O. Matkin, 2002. Cultural transmission within maternal lineages: Vocal clans in resident killer whales in southern Alaska. *Animal Behaviour*, Vol 63, pp 1103–1119.

Zamon, J. E., 2001. Seal predation on salmon and forage fish schools as a function of tidal currents in the San Juan Islands, Washington, USA. *Fisheries Oceanography*, Vol 10, pp 353–366.

Zani, M. A., J. K. D. Taylor, and S. D. Kraus, 2008. Observation of a right whale (*Eubalaena glacialis*) birth in the coastal waters of the southeast United States. *Aquatic Mammals*, Vol 34, No 1, pp 21–24.

Zani, M. A., J. K. D. Taylor, R. A. Salmon, and S. D. Kraus, 2005. Observation of a birth of a North Atlantic right whale (*Eubalaena glacialis*), in *Abstracts, Sixteenth Biennial Conference on the Biology of Marine Mammals*. 12–16 December, 2005. San Diego, California. p 314.

Zar, J. H., 1996. *Biostatistical analysis. 3rd ed*. Prentice Hall: Upper Saddle River, NJ.

Zaretsky, S. C., A. Martinez, L. P. Garrison, and E. O. Keith, 2005. Differences in acoustic signals from marine mammals in the western North Atlantic and northern Gulf of Mexico, in *Abstracts, Sixteenth Biennial Conference on the Biology of Marine Mammals*. 12-16 December, 2005. San Diego, California. p 314.

Zerbini, A. N., E. R. Secchi, S. Siciliano, and P. C. Simões-Lopes, 1997. A review of the occurrence and distribution of whales of the genus *Balaenoptera* along the Brazilian coast. *Reports of the International Whaling Commission*, Vol 47, pp 407–417.

Zhou, K., Q. Weijuan, and L. Yuemin, 1982. *Pseudorca crassidens* (Owen) from the coastal waters of China. *Investigations on Cetacea*, Vol 13, pp 263–269.

Zimmer, W. M. X., and P. L. Tyack, 2007. Repetitive Shallow Dives Pose Decompression Risk in Deep-Diving Beaked Whales. *Marine Mammal Science*, Vol 23, Issue 4, pp 888–925.

Zimmer, W. M. X., M. P. Johnson, P. T. Madsen, and P. L. Tyack, 2005. Echolocation clicks of free-ranging Cuvier's beaked whales (*Ziphius cavirostris*). *Journal of the Acoustical Society of America*, Vol 117, No 6, pp 3919–3927.

Zoodsma, B. J., 1991. *Distribution and behavioral ecology of manatees in southeastern Georgia: Kings Bay Environmental Monitoring Program, Cumberland Island National Seashore*. Resources Management Report SER-91/03. Atlanta, Georgia: National Park Service.

Zoodsma, B. J., 2006. Personal communication via email between Ms. Barb Zoodsma, National Marine Fisheries Service, Southeast Regional Office, and Ms. Dagmar Fertl, Geo-Marine, Inc., Plano, Texas, 28 Feburary.