National Marine Fisheries Service
Endangered Species Act Section 7 Consultation Biological Opinion

Agencies: United States Navy
National Marine Fisheries Service

Activities Considered: The U.S. Navy's Atlantic Fleet Training and Testing Activities from November 2013 through November 2018; and

The National Marine Fisheries Services' promulgation of regulations and issuance of letters of authorization pursuant to the Marine Mammal Protection Act for the U.S. Navy to "take" marine mammals incidental to Atlantic Fleet Training and Testing activities from November 2013 through November 2018

Consultation Conducted by: Endangered Species Act Interagency Cooperation Division of the Office of Protected Resources, National Marine Fisheries Service

Approved by:

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Date: NOV 14 2013

Section 7(a)(2) of the Endangered Species Act of 1973, as amended (ESA; 16 U.S.C. 1536(a)(2)) requires each federal agency to ensure that any action they authorize, fund, or carry out is not likely to jeopardize the continued existence of any endangered or threatened species or result in the destruction or adverse modification of critical habitat of such species. When a federal agency's action "may affect" a protected species, that agency is required to consult formally with the National Marine Fisheries Service (NMFS) or the U.S. Fish and Wildlife Service, depending upon the endangered species, threatened species, or designated critical habitat that may be affected by the action (50 CFR §402.14(a)). Federal agencies are exempt from this general requirement if they have concluded that an action "may affect, but is not likely to adversely affect" endangered species, threatened species, or designated critical habitat and NMFS or the U.S. Fish and Wildlife Service concur with that conclusion (50 CFR§402.14(b)).

In this biological opinion, the action agencies are the United States Navy (U.S. Navy), which proposes to undertake training and testing activities, and NMFS' Office of Protected Resources, Permits and Conservation Division, which proposes to promulgate regulations and issue letters of authorization to pursuant to the Marine Mammal Protection Act to authorize "take" of marine mammals incidental to Navy training and testing in the Atlantic Fleet Training and Testing Study Area. The consulting agency for these proposals is NMFS Office of Protected Resources - Endangered Species Act Interagency Cooperation Division.

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1 Introduction

The Endangered Species Act (ESA) of 1973, as amended (16 U.S.C. 1531 et seq.) establishes a national program for conserving threatened and endangered species of fish, wildlife, plants, and the habitat upon which they depend. Section 7(a)(2) of the ESA requires Federal agencies to consult with the United States Fish and Wildlife Service (USFWS), NMFS, or both, to ensure that their actions are not likely to jeopardize the continued existence of endangered or threatened species or adversely modify or destroy their designated critical habitat. Section 7(b)(3) requires that at the conclusion of consultation, the Service provide an opinion stating how the agencies' actions will affect listed species and their critical habitat. If an incidental take is expected, section 7(b)(4) requires the consulting agency to provide an incidental take statement (ITS) that specifies the impact of any incidental taking and includes reasonable and prudent measures to minimize such impacts.

When a Federal agency's action "may affect" a protected species, that agency is required to consult formally with NMFS or the USFWS, depending upon the endangered species, threatened species, or designated critical habitat that may be affected by the action (50 CFR §402.14(a)). Federal agencies are exempt from this general requirement if they have concluded that an action "may affect, but is not likely to adversely affect" endangered species, threatened species, or designated critical habitat and NMFS or the USFWS concurs with that conclusion (50 CFR §402.14(b)).

For the actions described in this document, the action agencies are the United States Navy (U.S. Navy), which proposes to conduct military training and testing activities and (2) NMFS Office of Protected Resources, Permits and Conservation Division (Permits Division), which proposes to promulgate regulations pursuant to the Marine Mammal Protection Act of 1972, as amended (MMPA 16 U.S.C. 1361 et seq.) related to the U.S. Navy's proposed activities in the Atlantic Fleet Training and Testing (AFTT) Study Area that may affect several ESA-listed species and to issue letters of authorization (LOA) that would allow the U.S. Navy to "take" marine mammals incidental to their proposed training and testing actions respectively. The consulting agency for these proposals is NMFS Office of Protected Resources, Endangered Species Act Interagency Cooperation Division.

The biological opinion (Opinion) and incidental take statement portions of this consultation were prepared by NMFS Endangered Species Act Interagency Cooperation Division in accordance with section 7(b) of the Endangered Species Act (ESA) of 1973, as amended (16 U.S.C. 1531, et seq.), and implementing regulations at 50 CFR §402. This document represents NMFS' final opinion on the effects of these actions on endangered and threatened species and critical habitat that has been designated for those species.

1.1 Background

This biological opinion is based on information provided in the 21 September 2012 U.S. Navy's request for ESA consultation package which included the *Atlantic Fleet Training and Testing*

Draft Environmental Impact Statement/Overseas Environmental Impact Statement (DEIS/OEIS) the *Atlantic Fleet Training and Testing Endangered Species Act Section 7 Consultation Supplemental Information*, and NMFS Permits Division's 6 February 3013 request for Section 7 consultation under the ESA, the proposed Federal regulations under the MMPA specific to the proposed activities (78 FR 7050). Also considered were the Final EIS/OEIS for Atlantic Fleet Training and Testing, draft or final recovery plans for the endangered or threatened species that are considered in this document, and publications that we identified, gathered, and examined from the public scientific literature.

The Navy proposes to conduct training and testing activities within the Atlantic Fleet Training and Testing (AFTT) Study Area. Navy training and testing activities have been ongoing in the same general geographic area for several decades. Ongoing activities that are analyzed in previous section 7 consultations are assessed in this Opinion as part of the *Environmental Baseline* in the action area.

1.2 Consultation History

- On 21 September 2012, the U.S. Navy requested section 7 formal consultation based on their determination that AFTT activities may affect and are likely to adversely affect North Atlantic right whale (*Eubalaena glacialis*), humpback whale (*Megaptera novaeangliae*), sei whale (*Balaenoptera borealis*), fin whale (*Balaenoptera physalus*), blue whale (*Balaenoptera musclus*), sperm whale (*Physeter macrocephalus*), green sea turtle (*Chelonia mydas*), hawksbill sea turtle (*Eretmochelys imbricata*), Kemp's ridley sea turtle (*Lepidochelys kempii*), loggerhead sea turtle (*Caretta caretta*), leatherback sea turtle (*Dermochelys coriacea*), largetooth sawfish (*Pristis pristis*), smalltooth sawfish (*Pristis pectinata*), Atlantic sturgeon (*Acipenser oxyrinchus oxyrinchus*) and Gulf sturgeon (*Acipenser oxyrinchus desotoi*). The U.S. Navy also requested NMFS concurrence on their determination of may affect, not likely to adversely affect for bowhead whale (*Balaena mysticetes*), Atlantic salmon (*Salmo salar*), shortnose sturgeon (*Acipenser brevirostrum*), elkhorn coral (*Acropora palmata*), staghorn coral (*Acropora cervicornis*), and designated critical habitats for Atlantic salmon, smalltooth sawfish, Gulf sturgeon, staghorn coral and elkhorn coral. The U.S. Navy also requested formal conference on the ringed seal (*Pusa hispida*), which at the time was proposed for listing.

- On 5 November 2012, we responded to the U.S. Navy's 21 September request indicating that we had received sufficient information to initiate formal consultation and conference. We also determined that NMFS Permits and Conservation Division's proposed action of promulgating a rule in accordance with the Marine Mammal Protection Act (MMPA) and subsequently issuing letters of authorization (LOA) authorizing take of marine mammals incidental to U.S. Navy AFTT activities are inter-dependent and interrelated to the U.S. Navy's proposed action and therefore must be included in the consultation. Due to the complexity of the proposed action and extent of species potentially affected, we proposed an extended consultation timeline with a final opinion issued no later than 24 October 2013.

- On 28 November 2012, U.S. Navy Fleet Forces Command staff provided a revised timeline via email requesting a final biological opinion no later than 15 October 2013.

- On 29 November 2012, we received a letter (dated 28 November 2012) from U.S. Navy Fleet Forces Command agreeing to extend consultation timelines and requesting a final biological opinion no later than 15 October 2013.

- On 29 November 2012, we concurred with the revised timeline via email.

- On 28 December 2012, 4 subspecies of ringed seals (Arctic, Okhotsk, Baltic and Ladoga) were listed as threatened and the Okhotsk and Beringia distinct population segments (DPSs) of bearded seals were listed threatened under the Endangered Species Act. NMFS and the Navy determined that the action area did not overlap the range of the two ESA-listed DPSs and therefore there would be no effect from AFTT. Any exposure of bearded seals to stressors from AFTT would be to non-listed populations which are protected under the MMPA.

- On 31 January 2013, NMFS' Permits Division published a notice of proposed rulemaking and request for comments for "Takes of Marine Mammals Incidental to Specified Activities; U.S. Navy Training and Testing Study Area; Proposed Rule."

- On 6 February 2013, NMFS' Permits Division provided a copy of the proposed rule to initiate consultation.

- On 20 February 2013, the Navy requested initiation of a conference on some of the coral species proposed for listing (Dec 2012, 77 FR 73219).

- On 22 March 2013, U.S. Navy Fleet Forces Command submitted supplemental information with Final EIS updates.

- On 18 June, 2013, U.S. Navy Fleet Forces Command submitted information, on NMFS' ESA Interagency Cooperation Division request, to change the likely to adversely affect determination for largetooth sawfish to not likely to adversely affect.

- On 14 August 2013, NMFS' Permits Division provided a revised draft Final Rule *Takes of Marine Mammals Incidental to Specified Activities; U.S. Navy Training and Testing Activities in the Atlantic Fleet Training and Testing Study Area.*

- On 15 August 2013, U.S. Navy Fleet Forces Command provided additional information on the *Post-Model Quantitative Analysis of Animal Avoidance Behavior and Mitigation Effectiveness for Atlantic Fleet Training and Testing.*

- On 16 August 2013, NMFS' ESA Interagency Cooperation Division provided a copy of the preliminary draft biological opinion to the U.S. Navy per agreed upon milestones. The Navy provided comments on the preliminary draft on 26 August 2013.

- On 3 September 2013, NMFS' Permits Division provided a revised draft Final Rule *Takes of Marine Mammals Incidental to Specified Activities; U.S. Navy Training and Testing Activities in the Atlantic Fleet Training and Testing Study Area.*

- On 19 September 2013, the Navy withdrew pile driving activities proposed as part of AFTT as they were determined to be interrelated and interdependent to Elevated Causeway System

(ELCAS) and overall Joint Logistics Over-the-Shore (JLOTS) training activities. These training activities will be assessed under a separate consultation on JLOTS.

- On 26 September 2013, the Navy and NMFS' Permits Division decided to remove pile driving activities associated with ELCAS from the AFTT MMPA Rule. These activities would be covered under a separate application for JLOTS along with the ESA Section 7 consultation.

- On 30 September 2013, NMFS' ESA Interagency Cooperation Division provided a copy of the draft biological opinion to the U.S. Navy, upon their request.

- On 24 October 2013, NMFS and the Navy agreed to extend the consultation to14 November 2013 due to the Government shutdown.

- On 4 November 2013, NMFS' Permits Division provided the Final Rule text for *Takes of Marine Mammals Incidental to Specified Activities; U.S. Navy Training and Testing Activities in the Atlantic Fleet Training and Testing Study Area.*

- On 6 November 2013, NMFS' Permits Division provided draft letters of authorization for U.S. Navy training and testing activities respectively. NMFS' ESA Interagency Cooperation Division worked closely with the Permits Division during development of the MMPA regulations and these draft letters of authorization.

2 Description of the Proposed Action

"Action" means all activities or programs of any kind authorized, funded, or carried out, in whole or in part, by Federal agencies. Interrelated actions are those that are part of a larger action and depend on the larger action for their justification. Interdependent actions are those that have no independent utility apart from the action under consideration. This opinion addresses three interdependent actions as proposed by the U.S. Navy and NMFS's Permits Division.

The U.S. Navy proposes to conduct training exercises and testing activities in the AFTT Study Area over a five year period following issuance of the MMPA Letters of Authorization in November 2013. This approach is consistent with Congress' intent that we coordinate and integrate the decision-making process under MMPA and ESA to the maximum extent practicable, so this opinion analyzes the training and testing activities during the time and in the geographic area covered by the MMPA regulations, which are limited to "periods of not more than five consecutive years." 16 U.S.C. 1371(a)(5)(A)(i). Further, NMFS has determined to structure this consultation in this way to ensure that the effects of reasonably anticipated training and testing activities may be analyzed close in time to their occurrence.

NMFS recognizes that while Navy training and testing requirements change over time in response to global or geopolitical events and other factors, the general types of activities addressed by this consultation are expected to continue into the reasonably foreseeable future, along with the associated impacts. Therefore, as part of our effects analysis, we assumed that the activities proposed for the next five years would continue into the reasonably foreseeable future at levels similar to that assessed in this opinion, and we considered the direct and indirect effects of those assumed future activities, together with the effects of all interrelated and interdependent actions. This approach addresses the recent court decision in Intertribal Sinkyone Wilderness Council v. National Marine Fisheries Service et al., No. 1:12-cv-00420-NJV (N.D. Cal. Sept. 25, 2013), although we may consider a different approach in future actions.

Notwithstanding this analysis, however, NMFS would fully take into account all of the best available science and any change in the status of the species when and if the Navy applies for a new MMPA incidental take authorization upon expiration of the five-year regulations considered in this opinion. The Navy would also need to initiate a new ESA consultation at that time.

The Navy categorizes training exercises and testing activities into functional warfare areas called primary mission areas. Training exercises fall into the following eight primary mission areas:

- Anti-air warfare
- Strike warfare
- Anti-submarine warfare
- Mine warfare
- Amphibious warfare
- Anti-surface warfare
- Electronic warfare
- Naval special warfare

U.S. Navy proposed training and testing activities and annual activity levels are summarized in this opinion. Specific details regarding each mission area can be found in the *Atlantic Fleet Training and Testing Environmental Impact Statement/Overseas Environmental Impact Statement (FEIS/OEIS)* (Navy 2013).

Also, NMFS' Permits Division proposes to issue 5-year regulations and lastly will issue subsequent Letters of Authorization (LOAs) to the U.S. Navy, pursuant to section 101(a)(5)(A) of the Marine Mammal Protection Act of 1972, as amended (MMPA; 16 U.S.C. 1361 *et seq.*), for taking marine mammals incidental to conducting training and testing in the AFTT Study Area. The MMPA regulations would be effective from November 2013 to November 2018.

2.1 U.S. Navy Proposed Training Exercises

2.1.1 Anti-Air Warfare (AAW)

The mission of anti-air warfare is to destroy or reduce enemy air and missile threats (including unmanned airborne threats) and serves two purposes: to protect U.S. forces from attacks from the air and to gain air superiority. Anti-air warfare also includes providing U.S. forces with adequate attack warnings, while denying hostile forces the ability to gather intelligence about U.S. forces.

Aircraft conduct anti-air warfare through radar search, detection, identification, and engagement of airborne threats-generally by firing anti-air missiles or cannon fire. Surface ships conduct anti-air warfare through an array of modern anti-aircraft weapon systems such as aircraft detecting radar, naval guns linked to radar-directed fire-control systems, surface-to-air missile systems, and radar-controlled cannons for close-in point defense.

Table 1. Typical Anti-Air Warfare Training Exercises

Activity Name	Activity Description
Air Combat Maneuver (ACM)	Aircrews engage in flight maneuvers designed to gain a tactical advantage during combat.

Air Defense Exercises (ADEX)	Aircrew and ship crews conduct defensive measures against threat aircraft or missiles.
Gunnery Exercise (Air-to-Air) (GUNEX [A-A])	Aircrews defend against threat aircraft with cannons (machine gun).
Missile Exercise (Air-to-Air) (MISSILEX [A-A])	Aircrews defend against threat aircraft with missiles.
Gunnery Exercise (Surface-to-Air) (GUNEX [S-A])	Surface ship crews defend against threat missiles and aircraft with guns.
Missile Exercise (Surface-to-Air) (MISSILEX [S-A])	Surface ship crews defend against threat missiles and aircraft with missiles.

2.1.2 **Amphibious Warfare (AMW)**

The mission of amphibious warfare is to project military power from the sea to the shore through the use of naval firepower and Marine Corps landing forces. It is used to attack a threat located on land by a military force embarked on ships. Amphibious warfare operations include small unit reconnaissance or raid missions to large-scale amphibious operations involving multiple ships and aircraft combined into a strike group.

Amphibious warfare training ranges from individual, crew, and small unit events to large task force exercises. Individual and crew training include amphibious vehicles and naval gunfire support training. Small-unit training operations include shore assaults, boat raids, airfield or port seizures, and reconnaissance. Large-scale amphibious exercises involve ship-to-shore maneuver, naval fire support, such as shore bombardment, and air strike and close air support training.

Table 2. Typical Amphibious Warfare Training Exercises

Activity Name	Activity Description
Naval Surface Fire Support Exercise–Land-based target (FIREX [Land])	Surface ship crews use large-caliber guns to fire on land-based targets in support of forces ashore.
Naval Surface Fire Support Exercise-At Sea (FIREX [At Sea])	Surface ship crews use large-caliber guns to support forces ashore; however, the land target is simulated at sea. Rounds impact the water and are scored by passive acoustic hydrophones located at or near the target area.
Marine Expeditionary Unit (MEU) Certification Exercise (CERTEX)	Amphibious Ready Group exercise conducted to validate the Marine expeditionary unit's readiness for deployment and includes small boat raids; visit, board, search, and seizure training; helicopter and mechanized amphibious raids; and a non-combatant evacuation operations.
Amphibious Assault	Forces move ashore from ships at sea for the immediate execution of inland objectives.
Amphibious Raid / Humanitarian Assistance Operations	Small unit forces move ashore swiftly from ships at sea for a specific short-term mission. These are quick operations with as few personnel as possible.

2.1.3 **Strike Warfare (STW)**

The mission of strike warfare is to conduct offensive attacks on land-based targets, such as refineries, power plants, bridges, major roadways, and ground forces to reduce the enemy’s ability to wage war. Strike warfare employs weapons by manned and unmanned air, surface, submarine, and naval special warfare assets in support of extending dominance over enemy territory (power projection).

Strike warfare includes training of fixed wing attack aircraft pilots and aircrews in the delivery of precision-guided munitions, non-guided munitions, rockets, and other ordnance, including the high-speed anti-radiation missile, against land-based targets in all conditions. Not all strike mission training events involve dropping ordnance and instead the event is simulated with video footage obtained by onboard sensors.

Table 3. Typical Strike Warfare Training Exercises

Activity Name	Activity Description
High-Speed Anti-Radiation Missile Exercise (Air- to- Surface) (HARMEX [A-S])	Aircrews launch a High-Speed Anti-Radiation Missile (HARM) against threat radar sites.

2.1.4 **Anti-Surface Warfare (ASUW)**

The mission of anti-surface warfare is to defend against enemy ships or boats. In the conduct of anti-surface warfare, aircraft use cannons, air-launched cruise missiles or other precision guided munitions; ships employ torpedoes, naval guns, and surface-to-surface missiles; and submarines attack surface ships using torpedoes or submarine-launched, anti-ship cruise missiles.

Anti-surface warfare training includes surface-to-surface gunnery and missile exercises, air-to-surface gunnery and missile exercises, and submarine missile or torpedo launch events.

Table 4. Typical Anti-Surface Warfare Training Exercises

Activity Name	Activity Description
Maritime Security Operations (MSO)	Helicopter and surface ship crews conduct a suite of maritime security operations (e.g., visit, board, search, and seizure; maritime interdiction operations; force protection; and anti-piracy operation).
Gunnery Exercise (Surface-to-Surface) (Ship) (GUNEX [S-S] – Ship)	Ship crews engage surface targets with ship's small, medium, and large caliber guns.
Gunnery Exercise (Surface-to-Surface) (Boat) (GUNEX [S-S] – Boat)	Small boat crews engage surface targets with small and medium-caliber guns.
Missile Exercise (Surface-to-Surface) (MISSILEX [S-S])	Surface ship crews defend against threat missiles and other surface ships with missiles.
Gunnery Exercise (Air-to-Surface) (GUNEX [A-S])	Fixed-wing and helicopter aircrews, including embarked personnel, use small and medium-caliber guns to engage surface targets.
Missile Exercise (Air-to-Surface) (MISSILEX [A-S])	Fixed-wing and helicopter aircrews fire both precision-guided missiles and unguided rockets against surface targets.
Bombing Exercise (Air-to-Surface) (BOMBEX [A-S])	Fixed-wing aircrews deliver bombs against surface targets.
Laser Targeting	Fixed-winged, helicopter, and ship crews use single or multi-beam lasers to illuminate enemy targets or to defend against approaching hostile forces.
Sinking Exercise (SINKEX)	Aircraft, ship, and submarine crews deliver ordnance on a seaborne target, usually a deactivated ship, which is deliberately sunk using multiple weapon systems.

2.1.5 Anti-Submarine Warfare (ASW)

The mission of anti-submarine warfare is to locate, neutralize, and defeat hostile submarine threats to surface forces. Anti-submarine warfare is based on the principle of a layered defense of surveillance and attack aircraft, ships, and submarines all searching for hostile submarines. These forces operate together or independently to gain early warning and detection, and to localize, track, target, and attack hostile submarine threats.

Anti-submarine warfare training addresses basic skills such as detection and classification of submarines, and distinguishing between sounds made by enemy submarines and those of friendly submarines, ships, and marine life. More advanced, integrated anti-submarine warfare training exercises are conducted in coordinated, at-sea training events involving submarines, ships, fixed wing aircraft, and helicopters. This training integrates the full spectrum of anti-submarine warfare from detecting and tracking a submarine to attacking a target using either exercise torpedoes or simulated weapons.

Table 5. Typical Anti-Submarine Warfare Training Exercises

Activity Name	Activity Description
Tracking Exercise/ Torpedo Exercise – Submarine (TRACKEX/TORPEX - Sub)	Submarine crews search, track, and detect submarines. Exercise torpedoes may be used during this event.
Tracking Exercise/ Torpedo Exercise – Surface (TRACKEX/TORPEX - Surface)	Surface ship crews search, track and detect submarines. Exercise torpedoes may be used during this event.
Tracking Exercise/ Torpedo Exercise – Helicopter (TRACKEX/TORPEX - Helo)	Helicopter crews search, detect and track submarines. Recoverable air launched torpedoes may be employed against submarine targets.
Tracking Exercise/ Torpedo Exercise - Maritime Patrol Aircraft (TRACKEX/TORPEX - MPA)	Maritime patrol aircraft crews search, detect, and track submarines. Recoverable air launched torpedoes may be employed against submarine targets.
Tracking Exercise - Maritime Patrol Aircraft Extended Echo Ranging Sonobuoy (TRACKEX – MPA sonobuoy)	Maritime patrol aircraft crews search, detect, and track submarines with extended echo ranging sonobuoys. Recoverable air launched torpedoes may be employed against submarine targets.
Anti-Submarine Warfare Tactical Development Exercise	Multiple ships, aircraft and submarines coordinate their efforts to search, detect and track submarines with the use of all sensors. Anti-submarine warfare tactical development exercise is a dedicated anti-submarine warfare event.
Integrated Anti-Submarine Warfare Course (IAC)	Multiple ships, aircraft, and submarines coordinate the use of their sensors, including sonobuoys, to search, detect and track threat submarines. Integrated Anti-Submarine Warfare Course is an intermediate level training event and can occur in conjunction with other major exercises.
Group Sail	Multiple ships and helicopters integrate the use of sensors, including sonobuoys, to search, detect and track a threat submarine. Group sails are not dedicated anti-submarine warfare events and involve multiple warfare areas.
Anti-Submarine Warfare for Composite Training Unit Exercise (COMPTUEX)	Anti-submarine warfare activities conducted during a composite training unit exercise.
Anti-Submarine Warfare for Joint Task Force Exercise (JTFEX)/	Anti-submarine warfare activities conducted during a joint task force exercise / sustainment exercise.

Sustainment Exercise (SUSTAINEX)	

2.1.6 Electronic Warfare (EW)

The mission of electronic warfare is to degrade the enemy's ability to use their electronic systems, such as communication systems and radar, in order to confuse or deny them the ability to defend their forces and assets. Electronic warfare is also used to recognize an emerging threat and counter an enemy's attempt to degrade the electronic capabilities of the Navy.

Typical electronic warfare activities include threat avoidance training, signals analysis for intelligence purposes, and use of airborne and surface electronic jamming devices to defeat tracking and communications systems.

Table 6. Typical Electronic Warfare Training Exercises

Activity Name	Activity Description
Electronic Warfare Operations (EW OPS)	Aircraft, surface ship and submarine crews attempt to control portions of the electromagnetic spectrum used by enemy systems to degrade or deny the enemy's ability to take defensive actions.
Counter Targeting - Flare Exercise (FLAREX)	Fixed-winged aircraft and helicopters crews defend against an attack by deploying flares to disrupt threat infrared missile guidance systems.
Counter Targeting - Chaff Exercise (CHAFFEX)	Surface ships, fixed-winged aircraft and helicopter crews defend against an attack by deploying chaff, a radar reflective material, which disrupt threat targeting and missile guidance radars.

2.1.7 Mine Warfare (MIW)

The mission of mine warfare is to detect, and avoid or neutralize mines to protect Navy ships and submarines and to maintain free access to ports and shipping lanes. Mine warfare also includes offensive mine laying to gain control of, or deny the enemy access to sea space. Naval mines can be laid by ships (including purpose-built minelayers), submarines, or aircraft.

Mine warfare neutralization (destruction) training includes exercises in which ships, aircraft, submarines, or underwater vehicles search for mines. Personnel train to destroy or disable mines by attaching and detonating underwater explosives to the mine. Other neutralization techniques involve impacting the mine with a bullet-like projectile or intentionally triggering the mine to detonate.

Table 7. Typical Mine Warfare Training Exercises

Activity Name	Activity Description
Mine Countermeasures Exercise (MCM) - Ship Sonar	Littoral combat ship crews detect and avoid mines while navigating restricted areas or channels using active sonar.
Explosive Ordnance Disposal (EOD)/Mine Neutralization	Personnel disable threat mines. Explosive charges may be used.
Underwater Mine Countermeasures (UMCM) Raise, Tow, Beach and Exploitation Operations	Personnel recover moored mines, transfer the mines to shore, and disassemble them.
Mine Countermeasures -Towed Mine Neutralization	Ship crews and helicopter aircrews tow systems (e.g., Organic and Surface Influence Sweep, MK 104/105) through the water designed to disable and/or trigger mines.
Mine Countermeasures - Mine	Ship crews and helicopter aircrews detect mines using towed and laser

Detection	mine detection systems (e.g., AN/AQS-20, Airborne Laser Mine Detection System).
Mine Countermeasures – Mine Neutralization	Ship crews and helicopter aircrews disable mines by firing small and medium-caliber projectiles.
Mine Countermeasures - Mine Neutralization – Remotely Operated Vehicles	Ship crews and helicopter aircrews disable mines using remotely operated underwater vehicles.
Mine Laying	Fixed-winged aircraft and submarine crews drop/launch non explosive mine shapes.
Coordinated Unit Level Helicopter Airborne Mine Countermeasure Exercises	Helicopters aircrew members train as a squadron in the use of airborne mine countermeasures, such as towed mine detection and neutralization systems.
Civilian Port Defense	Maritime security operations for military and civilian ports and harbors. Only the sonar portion of this activity is analyzed in this document, as other stressors were determined to have no effect to listed species. Marine mammal systems may be used during the exercise.

2.1.8 Naval Special Warfare

The mission of naval special warfare is to conduct unconventional warfare, direct action, combat terrorism, special reconnaissance, security assistance, counter-drug operations, and recovery of personnel from hostile situations. Naval special warfare operations are highly specialized and require continual and intense training.

Naval special warfare units utilize a combination of specialized training, equipment, and tactics, including insertion and extraction operations using parachutes, submerged vehicles, rubber boats, and helicopters; boat-to-shore and boat-to-boat gunnery; underwater demolition training; reconnaissance; and small arms training.

2.1.9 Major Training Exercises

A major training event is comprised of several "unit level" range exercises conducted by several units operating together while commanded and controlled by a single commander. These exercises typically employ an exercise scenario developed to train and evaluate the strike group in naval tactical tasks. In a major training event, most of the operations and activities being directed and coordinated by the strike group commander are identical in nature to the operations conducted during individual, crew, and smaller-unit training events. In a major training event, however, these disparate training tasks are conducted in concert, rather than in isolation. Typical major training exercises are described in the table below.

Table 8. Typical Major Training Exercises

Activity Name	Activity Description
Composite Training Unit Exercise (COMPTUEX)	Intermediate level exercise designed to create a cohesive Strike Group prior to deployment or joint task force exercise. Typically seven surface ships, helicopters, maritime patrol aircraft, two submarines, and various unmanned vehicles. Marine mammal systems may be used during the exercise.
Joint Task Force Exercise (JTFEX) / Sustainment Exercise (SUSTAINEX)	Final fleet exercise prior to deployment of the Strike Group. Serves as a ready-to-deploy certification for all units involved. Typically nine surface ships, helicopters, maritime patrol aircraft, two submarines, and various unmanned vehicles. Marine mammal systems may be used during the exercise.

2.1.10 Other Training Activities

Other training activities that do not fall under a particular category are described in the table below.

Table 9. Typical Other Training Activities

Activity Name	Activity Description
Search and Rescue (SAR)	Helicopter crews rescue military personnel at-sea.
Precision Anchoring	Ship crews train in releasing of anchors in designated locations.
Submarine Navigational (SUB NAV)	Submarine crews locate underwater objects and ships while transiting in and out of port.
Submarine Navigation Under Ice Certification	Submarine crews train to operate under ice. During training and certification other submarines and ships simulate ice.
Surface Ship Object Detection	Surface ship crews locate underwater objects that may impede transit in and out of port.
Surface Ship Sonar Maintenance	Pierside and at-sea maintenance of sonar systems.
Submarine Sonar Maintenance	Pierside and at-sea maintenance of sonar systems.

2.1.11 Proposed Training Exercise Levels

The following table provides a summary of training activities (as described in Section 2.1 above) including tempo and quantities of inert and live munitions that the U.S. plans to expend during training that were analyzed by the U.S. Navy. Munitions that contain high explosives (HE) are bolded in the table to highlight activities that might have greater potential for impact to listed species.

Table 10. Proposed Training Activities (adapted from Table 2.8-1, Alternative 2, U.S. Navy FEIS/OEIS, August 2013, pg 11)

Range Activity	No. of Events (per Year)	Ordnance (Number per Year)	Location
Anti-Air Warfare (AAW)			
Air Combat Maneuver (ACM)	3,200	None	VACAPES
	1,155	None	Cherry Point
	1,270	None	JAX
	5,700	None	Key West
Air Defense Exercise (ADEX)	595	None	VACAPES
	5,166	None	Cherry Point
	5,157	None	JAX
	85	None	GOMEX
Gunnery Exercise (Air-to-Air) – Medium-Caliber (GUNEX [A-A] – Medium-Caliber	120	96,000 rounds	VACAPES
	40	20,800 rounds	Cherry Point
	75	62,400 rounds	JAX
	70	56,000 rounds	Key West
Missile Exercise (Air-to-Air) (MISSILEX [A-A])	40	**40 missiles (HE)**	VACAPES
	43	**43 missiles (HE)**	Cherry Point
	37	**37 missiles (HE)**	JAX
	8	**8 missiles (HE)**	Key West
Gunnery Exercise (Surface-to-Air) – Large-Caliber (GUNEX [S-A]) – Large-Caliber	136	**1,760 rounds (HE)**	VACAPES
	84	**1,100 rounds (HE)**	JAX

Gunnery Exercise (Surface-to-Air) – Medium-Caliber (GUNEX [S-A]) – Medium-Caliber	180	409,200 rounds	VACAPES
	5	11,000 rounds	Cherry Point
	84	165,000 rounds	JAX
	14	30,000 rounds	Other AFTT Areas
Missile Exercise (Surface-to-Air) (MISSILEX [S-A])	4	**4 missiles (HE)**	Northeast
	32	**32 missiles (HE)**	VACAPES
	8	**8 missiles (HE)**	Cherry Point
	15	**15 missiles (HE)**	JAX
	8	**8 missiles (HE)**	GOMEX
Amphibious Warfare (AMW)			
Naval Surface Fire Support Exercise – Land-Based Target (FIREX [Land])	30	2,030 rounds	Firing Point: Cherry Point Impact Area: Camp Lejune Range G-10
Naval Surface Fire Support Exercise – At Sea (FIREX [At Sea])	32	2,328 rounds (**2,240 HE**)	VACAPES
	4	320 rounds (**280 HE**)	Cherry Point
	12	960 rounds (**840 HE**)	JAX
	2	160 rounds (**140 HE**)	GOMEX
Marine Expeditionary Unit (MEU) Certification Exercise (CERTEX)	2	None	Cherry Point
Amphibious Assault	10	None	Cherry Point: Onslow Bay
Amphibious Raid/ Humanitarian Assistance Operations	36	None	Cherry Point: Onslow Bay
	6	None	JAX: Mayport
Strike Warfare (STW)			
High-Speed Anti-Radiation Missile Exercise (Air-to-Surface) (HARMEX [A-S])	12	**12 missiles (HE)**	VACAPES
	8	**8 missiles (HE)**	Cherry Point
Anti-Surface Warfare (ASUW)			
Maritime Security Operations (MSO)	2	None	Northeast
	602	None	VACAPES
	70	None	Cherry Point
	152	None	JAX
	54	None	GOMEX
Maritime Security Operations (MSO) – Anti-Swimmer Grenades	2	**52 grenades (HE)**	Northeast
	4	**74 grenades (HE)**	VACAPES
	2	**28 grenades (HE)**	Cherry Point
	2	**24 grenades (HE)**	JAX
	2	**28 grenades (HE)**	GOMEX
Gunnery Exercise (Surface-to-Surface) – Ship Small-Caliber (GUNEX [S-S] – Ship) Small-Caliber	1,224	2,750,000 rounds	VACAPES
	150	212,240 rounds	Cherry Point
	80	1,100,000 rounds	JAX
	16	36,000 rounds	GOMEX
	70	201,000 rounds	Other AFTT Areas
Gunnery Exercise (Surface-to-Surface) – Ship Medium-Caliber (GUNEX [S-S] – Ship) Medium-Caliber	500	46,260 rounds (**5,000 HE**)	VACAPES
	63	35,100 rounds (**600 HE**)	Cherry Point
	200	21,240 rounds (**2,000 HE**)	JAX
	32	3,840 rounds (**320 HE**)	GOMEX
	32	3,840 rounds (**320 HE**)	Other AFTT Areas

Gunnery Exercise (Surface-to-Surface) - Ship Large-Caliber (GUNEX [S-S] - Ship) - Large-Caliber	120	4,360 rounds (**2,644 HE**)	VACAPES
	26	1,480 rounds (**586 HE**)	Cherry Point
	106	4,220 rounds (**2,508 HE**)	JAX
	24	1,400 rounds (**144 HE**)	GOMEX
	18	633 rounds (**96 HE**)	Other AFTT Areas
Gunnery Exercise (Surface-to-Surface) - Boat Small-Caliber (GUNEX [S-S] - Boat) - Small-Caliber	10	27,500 rounds	Northeast
	202	286,600 rounds	VACAPES
	32	135,500 rounds	Cherry Point
	200	123,800 rounds	JAX
	10	37,200 rounds	GOMEX
	18	26,500 rounds	Other AFTT Areas
Gunnery Exercise (Surface-to-Surface) – Boat Medium-Caliber (GUNEX [S-S] - Boat) - Medium-Caliber	2	700 rounds	Northeast
	204	127,536 rounds (**936 HE**)	VACAPES
	26	64,000 rounds (**626 HE**)	Cherry Point
	194	13,480 rounds (**120 HE**)	JAX
	8	2,900 rounds (**32 HE**)	GOMEX
Missile Exercise (Surface-to-Surface) (MISSILEX [S-S])	10	10 (**8 HE**)	VACAPES
	10	10 (**8 HE**)	JAX
Gunnery Exercise (Air-to-Surface) – Small-Caliber (GUNEX [A-S]) – Small-Caliber	619	821,000 rounds	VACAPES
	130	196,000 rounds	Cherry Point
	262	310,700 rounds	JAX
Gunnery Exercise [Air-to-Surface] – Medium-Caliber (GUNEX [A-S]) – Medium-Caliber	220	176,000 rounds (**44,000 HE**)	VACAPES
	210	104,800 rounds (**20,000 HE**)	Cherry Point
	245	198,400 rounds (**44,000 HE**)	JAX
	40	24,000 rounds (**6,000 HE**)	GOMEX
Missile Exercise (Air-to-Surface) – Rocket (MISSILEX [A-S]) - Rocket	100	3,800 rockets (**3,800 HE**)	VACAPES
	100	3,800 rockets (**3,800 HE**)	JAX
	10	3,80 rockets (**3,80 HE**)	GOMEX
Missile Exercise (Air-to-Surface) (MISSILEX [A-S])	98	98 missiles (**98 HE**)	VACAPES
	32	32 missiles (**32 HE**)	Cherry Point
	118	118 missiles (**118 HE**)	JAX
Bombing Exercise (Air-to-Surface) (BOMBEX [A-S])	359	674 bombs (**64 HE**)	VACAPES
	88	1,195 bombs (**32 HE**)	Cherry Point
	417	1,293 bombs (**32 HE**)	JAX
	66	339 bombs (**4 HE**)	GOMEX
Laser Targeting	272	None	VACAPES
	315	None	JAX
Sinking Exercise (SINKEX)	1	1 HE bomb; **11 HE missiles; 700 HE rounds**; **1 HE torpedo** (representative scenario)	Other AFTT Areas: SINKEX Box
Anti-Submarine Warfare (ASW)			
Tracking Exercise/ Torpedo Exercise – Submarine	24		Northeast
	8		VACAPES
	1		Cherry Point

(TRACKEX/ TORPEX – Sub)	25		Jax
	0		GOMEX
	44		Other AFTT Areas
	102	80 torpedoes	Total
Tracking Exercise/ Torpedo Exercise – Surface (TRACKEX/ TORPEX – Surface)	3		Northeast
	201		VACAPES
	47		Cherry Point
	412		JAX
	3		GOMEX
	98		Other AFTT Areas
	764	18 torpedoes	Total
Tracking Exercise/ Torpedo Exercise – Helicopter (TRACKEX/ TORPEX – Helo)	12		VACAPES
	12		Cherry Point
	384		JAX
	24		Other AFTT Areas
	432	18 torpedoes	Total
Tracking Exercise/Torpedo Exercise - Maritime Patrol Aircraft (TRACKEX/TORPEX – MPA)	79		Northeast
	158		VACAPES
	40		Cherry Point
	475		JAX
	0		GOMEX
	752	18 torpedoes	Total
Tracking Exercise - Maritime Patrol Aircraft Extended Echo Ranging Sonobuoys (TRACKEX–MPA Sonobuoy)	34	**170 HE sonobuoys**	JAX
	68	**340 HE sonobuoys**	VACAPES
	16	**80 HE sonobuoys**	Cherry Point
	202	**1,010 HE sonobuoys**	JAX
	0	None	GOMEX
	320		Total
Anti-Submarine Warfare Tactical Development Exercise	4	None	JAX
Integrated Anti-Submarine Warfare Course	0	None	VACAPES
	2	None	Cherry Point
	2	None	JAX
	1	None	GOMEX
Group Sail	5	**35 HE sonobuoys**	VACAPES
	5	**35 HE sonobuoys**	Cherry Point
	10	**70 HE sonobuoys**	JAX
Submarine Command Course (SCC) Operations	This event is included in TRACKEX/TORPEX – SUB training event		
ASW For Composite Training Unit Exercise (COMPTUEX)	4	**280 HE sonobuoys**	VACAPES/Cherry Point/ JAX
	1	**70 HE sonobuoys**	GOMEX
ASW For Joint Task Force Exercise (JTFEX)/ Sustainment Exercise (SUSTAINEX)	4	**28 HE sonobuoys**	VACAPES/Cherry Point/ JAX
Electronic Warfare (EW)			
Electronic Warfare Operations (EW Ops)	302	None	VACAPES
	2,620	None	Cherry Point
	181	None	JAX
Counter Targeting Flare	104	None	VACAPES

Exercise (FLAREX)	377	None	Cherry Point
	318	None	JAX
	368	None	GOMEX
	900	None	Key West
Counter Targeting Chaff Exercise (CHAFFEX) - Ship	37	None	VACAPES
	74	None	Cherry Point
	78	None	JAX
	18	None	GOMEX
Counter Targeting Chaff Exercise (CHAFFEX) – Aircraft	157	None	VACAPES
	686	None	Cherry Point
	532	None	JAX
	62	None	GOMEX
	3,000	None	Key West
Mine Warfare (MIW)			
Mine Countermeasures Exercise (MCM) – Ship Sonar	48	None	VACAPES
	48	None	JAX
	20	None	GOMEX
Mine Neutralization – Explosive Ordnance Disposal (EOD)	524	**524 HE charges**	VACAPES
	30	**1,518 HE charges**	VACAPES: Little Creek
	16	**16 HE charges**	Cherry Point
	20	**20 HE charges**	JAX
	16	**16 HE charges**	GOMEX
	12	**12 HE charges**	Key West
Underwater Mine Countermeasure (UMCM) Raise, Tow, Beach, and Exploitation Operations	290	None	VACAPES
	24	None	Cherry Point
	56	None	JAX
	56	None	GOMEX
Airborne Mine Countermeasure (AMCM) – Towed Mine Neutralization	880	None	VACAPES
	183	None	Cherry Point
	155	None	JAX
	94	None	GOMEX
Airborne Mine Countermeasure (AMCM) – Mine Detection	1,540	None	VACAPES
	371	None	Cherry Point
	317	None	JAX
	310	None	GOMEX
Mine Countermeasure (MCM) – Mine Neutralization Small and Medium-Caliber	110	2,750 rounds	VACAPES
	27	675 rounds	Cherry Point
	27	675 rounds	JAX
Mine Countermeasure (MCM) - Mine Neutralization – Remotely Operated Vehicle	630	630 neutralizers (**60 HE**)	VACAPES
	71	71 neutralizers	Cherry Point
	71	71 neutralizers	JAX
	132	132 neutralizers (**20 HE**)	GOMEX
Mine Laying	4	48 mine shapes	VACAPES
	2	24 mine shapes	Cherry Point
	1	12 mine shapes	JAX
Coordinated Unit Level Helicopter Airborne Mine Countermeasure Exercises	2	None	VACAPES
	2	None	Cherry Point
	2	None	JAX
	2	None	GOMEX
Civilian Port Defense	1 event every other year (3 total)	**4 HE Charges**	Occurs in a different area each year in waters around

			Earle, NJ; Groton, CT; Hampton Roads, VA; Morehead City, NC; Wilmington, NC; Kings Bay, GA; Mayport, FL; Beaumont, TX; Corpus Christi, TX
Major Exercises			
Composite Training Unit Exercise (COMPTUEX)	5		VACAPES/ Cherry Point/ JAX/ GOMEX
Joint Task Force Exercise (JTFX)/ Sustainment Exercise (SUSTAINEX)	4		VACAPES/ Cherry Point/ JAX
Other Training Activities			
Search and Rescue (SAR)	42	None	JAX
Precision Anchoring	640	None	VACAPES
	210	None	JAX
	8	None	GOMEX
Submarine Navigational (SUB NAV)	169	None	Northeast
	84	None	VACAPES
	29	None	JAX
Submarine Under Ice Certification	9	None	Northeast
	9	None	VACAPES
	3	None	Cherry Point
	3	None	JAX
Surface Ship Object Detection	80	None	VACAPES
	64	None	JAX
Surface Ship Sonar Maintenance (in OPAREAs and Ports)	358	None	VACAPES
	110	None	Cherry Point
	324	None	JAX
	0	None	GOMEX
	32	None	Other AFTT Areas
Submarine Sonar Maintenance (in OPAREAs and Ports)	132	None	Northeast
	68	None	VACAPES
	0	None	Cherry Point
	8	None	JAX
	12	None	Other AFTT Areas

Understanding the number of munitions detonating in water is critical to assessing potential impacts from acoustic stressors, potential strike and fragments resulting from exploded munitions. Table 11 and Table 12 below provide the number and source of these munitions.

Table 11. Proposed Annual Number of Impulsive Source Detonations During Training in the AFTT Study Area

Explosive Class	Net Explosive Weight (NEW)	Annual In-Water Detonations (Training)
E1	(0.1 lb. – 0.25 lb.)	124,552
E2	(0.26 lb. – 0.5 lb.)	856

E3	(>0.5 lb. – 2.5 lb.)	3,132
E4	(>2.5 lb.-5 lb.)	2,190
E5	(>5 lb.-10 lb.)	14,370
E6	(>10 lb.-20 lb.)	500
E7	(>20 lb.-60 lb.)	322
E8	(>60 lb.-100 lb.)	77
E9	(>100 lb. – 250 lb.)	2
E10	(>250 lb. – 500 lb.)	8
E11	(>500 lb. – 650 lb.)	1
E12	(>650 lb. – 1,000 lb.)	133
E13	(>1,000 lb. – 1,740 lb.)	-

Table 12. Proposed Annual Number of Impulsive Source Detonations During Non-Annual Training Exercises Within the AFTT Study Area

Explosive Class	Net Explosive Weight (NEW)	Non-Annual In-Water Detonations (Testing)
E2	(0.26 lb. – 0.5 lb.)	Average of 2
E4	(>2.5 lb.-5 lb.)	Average of 2

Understanding the frequency and duration of active sonar sources is imperative in our risk analysis for stressors resulting from non-impulsive sound sources. Table 13 and Table 14 below provide the annual hours of these sources in the AFTT Study Area.

Table 13. Annual hours and items of non-impulsive sources used during training within the AFTT Study Area

Source Class Category	Source Class	Average Annual Use
Mid-Frequency (MF) Active sources from 1 to 10 kHz	MF1	9,844 hours
	MF1K	163 hours
	MF2	3,150 hours
	MF2K	61 hours
	MF3	2,058 hours
	MF4	927 hours
	MF5	14,556 items
	MF11	800 hours
	MF12	687 hours

High-Frequency (HF) and Very High-Frequency (VHF) Tactical and non-tactical sources that produce signals greater than 10kHz but less than 200kHz	HF1	1,676 hours
	HF4	8,464 hours
Anti-Submarine Warfare (ASW)	ASW1	128 hours
Active ASW sources	ASW2	2,620 items
	ASW3	13,586 hours
	ASW4	1,365 items
Torpedoes (TORP)	TORP1	54 items
Active torpedo sonar	TORP2	80 items

Table 14. Annual Hours and Items of Non-Impulsive Sources used During Non-Annual Training Within the AFTT Study Area

Source Class Category	Source Class	Average Non-Annual Use
High-Frequency (HF) and Very High-Frequency (VHF) Tactical and non-tactical sources that produce signals greater than 10kHz but less than 200kHz	HF4	192 hours

2.2 U.S. Navy Proposed Testing Activities

The Navy's research and acquisition community engages in a broad spectrum of testing activities in support of the fleet. These activities support the Navy's basic and applied scientific research and technology development, test evaluation and maintenance and acquisition missions.

The individual commands within the research and acquisition community included in the U.S. Navy's FEIS/OEIS are Naval Air Systems Command, Naval Sea Systems Command, and the Office of Naval Research and Naval Research Laboratory.

Some testing activities are similar to training activities conducted by the Atlantic Fleet. For example, both the Fleet and the research and acquisition community fire torpedoes. While the firing of a torpedo might look identical to an observer, the difference is in the purpose of the firing. The Fleet might fire the torpedo to practice the procedures for such a firing, whereas the research and acquisition community might be assessing a new torpedo guidance technology or to ensure the torpedo meets performance specifications and operational requirements. These differences may result in different analysis and potential mitigations for the activity.

2.2.1 Naval Air Systems Command Testing Activities

Naval Air Systems Command testing activities generally fall in the primary mission areas used by the fleets. Naval Air Systems Command activities include, but are not limited to, the testing of new aircraft platforms, weapons, and systems before those platforms, weapons, and systems are integrated into the fleet. In addition to the testing of new platforms, weapons, and systems, Naval Air Systems Command also conducts lot acceptance testing of weapons and systems, such as sonobuoys.

The majority of testing and development activities conducted by Naval Air Systems Command are similar to Atlantic Fleet training events, and many platforms (e.g., the MH-60 helicopter) and systems (e.g., Airborne Towed Mine-hunting System (AN/AQS-20A)) currently being tested are already being used by the Fleet or will ultimately be integrated into Fleet training activities. However, some testing and development may be conducted in different locations and in a different manner than the fleet and, therefore, though the potential environmental effects may be the same, the analysis for those events may differ.

Table 15. Typical Naval Air Systems Command Testing Activities

Activity Name	Activity Description
Anti-Air Warfare (AAW)	
Air Combat Maneuver (ACM) Test	This event is identical to the air combat maneuver training event. Test events involve two or more aircraft, each engaged in continuous proactive and reactive changes in aircraft attitude, altitude, and airspeed. No weapons are fired during air combat maneuver test activities.
Air Platform/Vehicle Test	Testing performed to quantify the flying qualities, handling, airworthiness, stability, controllability, and integrity of an air platform or vehicle. No weapons are released during an air platform/vehicle test. In-flight refueling capabilities are tested.
Air Platform Weapons Integration Test	Testing performed to quantify the compatibility of weapons with the aircraft from which they would be launched or released. Mostly non-explosive weapons or shapes are used, but some tests may require the use of high-explosive weapons.
Air-to-Air (A-A) Weapons System Test	Test to evaluate the effectiveness of air-launched weapons against designated airborne targets. Fixed-wing or rotary-wing aircraft may be used. No testing of high-explosive weapons is planned.
Air-to-Air Missile Test	This event is similar to the training event missile exercise (air-to-air). Tests are a type of air-to-air weapon system test in which non-explosive practice air-to-air missiles are fired from fixed wing aircraft against unmanned aerial drones such as BQM-34 and BQM-74.
Air-to-Air Gunnery Test	This event is similar to the training event gunnery exercise air-to-air. An air-to-air gunnery test involves the firing of guns from both fixed wing and rotary-wing aircraft against a towed aerial banner which serves as the target. Typically non-explosive practice rounds are fired and the targets fired upon are unmanned aerial drones.
Intelligence, Surveillance, and Reconnaissance Test	Test to evaluate communications capabilities of fixed wing and rotary-wing aircraft, including unmanned systems that can carry cameras, sensors, communications equipment, or other payloads. New systems are tested at sea to ensure proper communications between aircraft and ships.

Anti-Surface Warfare (ASUW)	
Air-to-Surface Missile Test	This event is similar to the training event missile exercise (air-to-surface). Test may involve both fixed-wing and rotary-wing aircraft launching missiles at surface maritime targets to evaluate the weapon system or as part of another systems integration test.
Air-to-Surface Gunnery Test	This event is similar to the training event gunnery exercise (air-to-surface). Strike fighter and helicopter aircrews evaluate new or enhanced aircraft guns against surface maritime targets to test that the gun, gun ammunition, or associated systems meet required specifications or to train aircrew in the operation of a new or enhanced weapon system.
Rocket Test	Rocket testing evaluates the integration, accuracy, performance, and safe separation of laser-guided and unguided 2.75-in. rockets fired from a hovering or forward flying helicopter or from a fixed-wing strike aircraft.
Air-to-Surface Bombing Test	This event is similar to the training event bombing exercise (air-to-surface). Strike fighter and maritime patrol aircraft test the delivery of non-explosive practice bombs against surface maritime targets with the goal of evaluating the bomb, the bomb carry and delivery system, and any associated systems that may have been newly developed or enhanced.
Laser Targeting Test	Aircrew use laser targeting devices integrated into aircraft or weapon systems to evaluate targeting accuracy and precision and to train aircrew in the use of newly developed or enhanced laser targeting devices. Lasers are designed to illuminate designated targets for engagement with laser-guided weapons.
High Energy Laser Weapons Test	High energy laser weapons tests evaluate the specifications, integration, and performance of an aircraft mounted, approximately 25 kW high energy laser. The laser is intended to be used as a weapon to disable small surface vessels.
Electronic Warfare (EW)	
Electronic Systems Evaluation	Test that evaluates the effectiveness of electronic systems to control, deny, or monitor critical portions of the electromagnetic spectrum. In general, electronic warfare testing will assess the performance of three types of electronic warfare systems: electronic attack, electronic protect, and electronic support.
Chaff Test	Similar to the training event counter targeting - chaff exercise, chaff tests evaluate newly developed or enhanced chaff, chaff dispensing equipment, or modified aircraft systems against chaff deployment. Tests may also train pilots and aircrew in the use of new chaff dispensing equipment. Chaff tests are often conducted with flare tests and air combat maneuver events, as well as other test events, and are not typically conducted as stand alone tests.
Flare Test	Similar to the training event counter targeting - flare exercise, flare tests evaluate newly developed or enhanced flares, flare dispensing equipment, or modified aircraft systems against flare deployment. Tests may also train pilots and aircrew in the use of newly developed or modified flare deployment systems. Flare tests are often conducted with chaff tests and air combat maneuver events, as well as other test events, and are not typically conducted as stand-alone tests.
Anti-Submarine Warfare (ASW)	
Anti-Submarine Warfare Torpedo Test	This event is similar to the training event torpedo exercise. The test evaluates antisubmarine warfare systems onboard rotary-wing and fixed-wing aircraft and the ability to search for, detect, classify, localize, and track a submarine or similar target.
Kilo Dip	A kilo dip is the operational term used to describe a functional check of a

	helicopter deployed dipping sonar system. The sonar system is briefly activated to ensure all systems are functional. A kilo dip is simply a precursor to more comprehensive testing.
Sonobuoy Lot Acceptance Test	Sonobuoys are deployed from surface vessels and aircraft to verify the integrity and performance of a lot, or group, of sonobuoys in advance of delivery to the fleet for operational use.
Anti-Submarine Warfare Tracking Test—Helicopter	This event is similar to the training event anti-submarine warfare tracking exercise/torpedo exercise - helicopter. The test evaluates the sensors and systems used to detect and track submarines and to ensure that helicopter systems used to deploy the tracking systems perform to specifications.
Anti-Submarine Warfare Tracking Test—Maritime Patrol Aircraft	This event is similar to the training event anti-submarine warfare tracking exercise/torpedo exercise -Maritime Patrol Aircraft extended echo ranging sonobuoy. The test evaluates the sensors and systems used by Maritime Patrol Aircraft to detect and track submarines and to ensure that aircraft systems used to deploy the tracking systems perform to specifications and meet operational requirements.
Mine Warfare (MIW)	
Airborne Mine Neutralization Test – AN/ASQ-235 (AMNS)	Airborne mine neutralization tests of the AN/ASQ-235 evaluate the system's ability to detect and destroy mines. The AN/ASQ-235 uses up to four unmanned underwater vehicles equipped with high-frequency sonar, video cameras, and explosive neutralizers.
Airborne Projectile-based Mine Clearance System	An MH-60S helicopter uses a laser-based detection system to search for mines and to fix mine locations for neutralization with an airborne projectile-based mine clearance system. The system neutralizes mines by firing a small or medium-caliber inert, supercavitating projectile from a hovering helicopter.
Airborne Towed Minesweeping Test – AN/ALQ-220 (OASIS)	Tests of the Organic Airborne and Surface Influence Sweep (OASIS) would be conducted by an MH-60S helicopter to evaluate the functionality of Organic Airborne and Surface Influence Sweep and the MH-60S at sea. The Organic Airborne and Surface Influence Sweep is towed from a forward flying helicopter and works by emitting an electromagnetic field and mechanically generated underwater sound to simulate the presence of a ship. The sound and electromagnetic signature cause nearby mines to explode.
Airborne Towed Minehunting Sonar Test – AN/AQS-20A	Tests of the AN/AQS-20A to evaluate the search capabilities of this towed, mine hunting, detection, and classification system. The sonar on the AN/AQS-20A identifies mine-like objects in the deeper parts of the water column.
Airborne Laser-Based Mine Detection System Test (ALMDS)	An airborne mine hunting test of the AN/AES-1 Airborne Laser Mine Detection System, or "ALMDS" evaluates the system's ability to detect, classify, and fix the location of floating and near-surface, moored mines. The system uses a laser to locate mines and may operate in conjunction with an airborne projectile-based mine detection system to neutralize mines.
Mine Laying Test	Fixed winged aircraft evaluate the performance of mine laying equipment and software systems to lay mines. A mine test may also train aircrew in laying mines using a new or enhanced mine deployment system.
Other Testing Activities	
Test and Evaluation Catapult Launch	Tests evaluate the function of aircraft carrier catapults at sea following enhancements, modifications, or repairs to catapult launch systems. This includes aircraft catapult launch tests. No weapons or other expendable materials would be released.
Air Platform Shipboard	Tests evaluate the compatibility of aircraft and aircraft systems with ships

Integrate Test	and shipboard systems. Tests involve physical operations and verify and evaluate communications and tactical data links. This test function also includes an assessment of carrier-shipboard suitability and hazards of electromagnetic radiation to personnel, ordnance, and fuels.
Shipboard Electronic Systems Evaluation	Tests measure ship antenna radiation patterns and test communication systems with a variety of aircraft.
Maritime Security	Maritime patrol aircraft and helicopters participate in maritime security activities and fleet training events. Aircraft and surface ships identify, track, intercept, board, and inspect foreign merchant vessels suspected of not complying with United Nations/allied sanctions or conflict rules of engagement.

2.2.2 Naval Sea Systems Command Testing Activities

Naval Sea Systems Command testing activities are aligned with its mission of new ship construction, life cycle support, and weapon systems development. Each major category of Naval Sea Systems Command activities is described below:

2.2.2.1 *New Ship Construction Activities*

Ship construction activities include pierside testing of ship systems, tests to determine how the ship performs at sea (sea trials), and developmental and operational test and evaluation programs for new technologies and systems. Pierside and at-sea testing of systems aboard a ship may include sonar, acoustic countermeasures, radars, and radio equipment. In the FEIS/OEIS, pierside testing at Navy contractor shipyards consists only of sonar systems. During sea trials, each new ship propulsion engine is operated at full power and subjected to high-speed runs and steering tests. At-sea test firing of shipboard weapon systems, including guns, torpedoes, and missiles, are also conducted.

2.2.2.2 *Shock Trials*

One ship of each new class (or major upgrade) of combat surface ships constructed for the Navy typically undergo an at-sea shock trial. A shock trial is a series of underwater detonations that send a shock wave through the ship's hull to simulate near misses during combat. A shock trial allows the Navy to validate the shock hardness of the ship and assess the survivability of the hull and ship's systems in a combat environment as well as the capability of the ship to protect the crew.

Table 16. Typical Ship Construction and Maintenance Activities

Ship Construction and Maintenance		
New Ship Construction		
Activity Name		Activity Description
Surface Combatant Sea Trials	Pierside Sonar Testing	Ship’s sonar systems are tested pierside to ensure proper operation.
	Propulsion Testing	Ship is run at high speeds in various formations (e.g., straight-line and reciprocal paths).
	Gun Testing	Gun systems are tested using non-explosive practice munitions.
	Missile Testing	Launching systems are tested using missiles fired at target drones.
	Decoy Testing	Includes testing of the MK 36 Decoy Launching system.
	Surface Warfare Testing-	Ships defend against surface targets with large-caliber

	Large Caliber	guns.
	Anti-Submarine Warfare Testing	Ships demonstrate capability of countermeasure systems and underwater surveillance and communications systems.
Aircraft Carrier Sea Trials	Propulsion Testing	Ship is run at high speeds in various formations (e.g., straight-line and reciprocal paths).
	Gun Testing-Small Caliber	Small-caliber gun systems are tested using non-explosive rounds.
	Gun Testing-Medium Caliber	Medium-caliber gun systems are tested using non-explosive and explosive rounds.
	Missile Testing	Missile systems are tested using explosive rounds.
	Bomb Testing	Non-explosive bombs are tested.
Submarine Sea Trials	Pierside Sonar Testing	Submarine sonar systems are tested pierside to ensure proper operation.
	Propulsion Testing	Submarine is run at high speeds in various formations and at various depths.
	Weapons Testing	Submarine weapons systems are tested by cycling water through them in lieu of actual weapons firing.
	Anti-Submarine Warfare Testing	Submarines demonstrate capability of underwater surveillance and communications systems.
Other Ship Class Sea Trials	Propulsion Testing	Ship is run at high speeds in various formations (e.g., straight-line and reciprocal paths).
	Gun Testing- Small Caliber	Small-caliber gun systems are tested using non-explosive rounds.
Anti-Submarine Warfare Mission Package Testing		Ships and their supporting platforms (e.g., helicopters, unmanned aerial systems) detect, localize, and prosecute submarines.
Surface Warfare Mission Package Testing		Ships defend against surface targets with small, medium, and large-caliber guns and medium range missiles.
Mine Countermeasure Mission Package Testing		Ships conduct mine countermeasure operations.
Post- Homeporting Testing (all classes)		Electronic, navigation, and refueling capabilities are tested.
Shock Trials		Explosives are detonated underwater against surface ships.

2.2.2.3 ***Life Cycle Activities***

Testing activities are conducted throughout the life cycle of a Navy ship to verify performance and mission capabilities. Sonar system testing occurs pierside during maintenance, repair, and overhaul availabilities, and at sea immediately following most major overhaul periods. A Combat System Ship Qualification Trial is conducted for new ships and for ships that have undergone modification or overhaul of their combat systems.

Radar cross signature testing of surface ships is conducted on new vessels and periodically throughout a ship's life cycle to measure how detectable the ship is to radar. Additionally, electromagnetic measurements of off-board electromagnetic signatures are conducted for submarines, ships, and surface craft periodically.

Table 17. Life Cycle Activities

Life Cycle Activities

Activity Name	Activity Description
Ship Signature Testing	Ship and submarine radars and electromagnetic signatures are tested.
Surface Ship Sonar Testing / Maintenance	Pierside and at-sea testing of ship systems occurs periodically following major maintenance periods and for routine maintenance.
Submarine Sonar Testing / Maintenance	Pierside and at-sea testing of submarine systems occurs periodically following major maintenance periods and for routine maintenance.
Combat System Ship Qualification Trial (CSSQT) - In-Port Maintenance Period	All combat systems are tested to ensure they are functioning in a technically acceptable manner and are operationally ready to support at-sea CSSQT events.
Combat System Ship Qualification Trial (CSSQT) - Air Defense (AD)	Ship's capability to detect, identify, track, and successfully defend against live and simulated targets is tested.
Combat System Ship Qualification Trial (CSSQT) – Surface Warfare (SUW)	Capabilities of shipboard sensors to detect and track surface targets, relay the data to the gun weapon system, and defend against targets are tested.
Combat System Ship Qualification Trial (CSSQT) – Undersea Warfare (USW)	Ship's ability to track and defend against undersea targets is tested.

2.2.2.4 ***Range Activities***

Naval Sea Systems Command's testing ranges are used to conduct principal testing, analysis, and assessment activities for ship and submarine platforms, including ordnance, mines, and machinery technology for surface combat systems. Naval Surface Warfare Center, Panama City Division Testing Range focuses on surface warfare tests that often involve mine countermeasures such as sonar operations, electromagnetic operations, laser operations, and ordnance/projectile operations. Naval Undersea Warfare Center Division, Newport Testing Range focuses on the undersea aspects of warfare and is, therefore, structured to test systems such as torpedoes and unmanned underwater vehicles. The South Florida Ocean Measurement Facility Testing Range retains a unique capability that focuses on signature analysis operations and mine warfare testing events.

Table 18. Typical Naval Sea Systems Command Range Activities

Naval Sea Systems Command Range Activities	
Naval Surface Warfare Center, Panama City Division Testing Range	
Activity Name	**Activity Description**
Air Operations	Various aircraft operations are conducted in support of other test activities.
Surface Operations	Surface vessel operations for deployment and recovery of mine warfare systems and testing of communication and propulsion systems are conducted.
Subsurface Operations	Subsurface operations include testing of underwater vehicles, items placed on the ocean floor, and diving activities.
Sonar Operations	Testing of sonar systems determines their capability to detect, locate, and characterize mine-like objects.
Electromagnetic Operations	Electromagnetic operations test an array of magnetic sensors used in mine countermeasure operations.
Laser Operations	Laser systems are tested to determine effectiveness as a tool to identify mine-like objects.

Ordnance Operations	Airborne, surface, organic (readily available units in place), and shallow water mine countermeasure systems are tested using explosive ordnance.
Projectile Firing	Airborne and surface crews defend against surface targets with small, medium, and large-caliber guns.
Unmanned Underwater Vehicles Demonstration	The performance of multiple unmanned underwater vehicles and associated acoustic, optical, and magnetic systems are tested and demonstrated.
Mine Detection and Classification Testing	Air, surface, and subsurface vessels detect and classify mines and mine-like objects.
Mine Countermeasure / Neutralization Testing	Air, surface, and subsurface vessels neutralize threat mines and mine-like objects.
Stationary Source Testing	Stationary equipment (including swimmer defense systems) is deployed to determine functionality.
Special Warfare Testing	Submersibles capable of inserting and extracting personnel or payloads into denied areas from strategic distances are tested.
Unmanned Underwater Vehicle Testing	Unmanned underwater vehicles are deployed to evaluate hydrodynamic parameters, to full mission, multiple vehicle functionality assessments.
Ordnance Testing	Airborne and surface crews defend against surface targets with small, medium, and large-caliber guns, as well as line charge testing.
Naval Undersea Warfare Center Division, Newport Testing Range	
Launcher Testing	Launcher systems are tested to evaluate performance.
Torpedo Testing	Non-explosive practice torpedoes are launched to record operational data.
Towed Equipment Testing	Surface vessel or unmanned underwater vehicle deploys equipment to determine functionality of towed systems.
Unmanned Underwater Vehicle Testing	Unmanned underwater vehicles are deployed to evaluate hydrodynamic parameters, to full mission, multiple vehicle functionality assessments.
Unmanned Surface Vehicle Testing	Unmanned surface vehicles are deployed to verify the functionality of basic capabilities and complex tests that involve multiple participants and missions.
Unmanned Aerial System Testing	Unmanned aerial systems are launched to test the capability to perform intelligence, surveillance, and reconnaissance, and extend the communications range of unmanned underwater vehicles, unmanned surface vehicles, and submarines.
Semi-Stationary Equipment Testing	Semi-stationary equipment (e.g., a hydrophone) is deployed to determine functionality.
Unmanned Underwater Vehicle Demonstrations	The performance of multiple unmanned underwater vehicles and associated acoustic, optical, and magnetic systems is tested and demonstrated.
Pierside Integrated Swimmer Defense Testing	Swimmer defense testing ensures that systems can effectively detect, characterize, verify, and defend against swimmer/diver threats in harbor environments.
South Florida Ocean Measurement Facility Testing Range	
Signature Analysis Operations	Electromagnetic, acoustic, optical, and radar signature measurements of surface ships and submarines are tested.
Mine Testing Activities	Air, surface, and sub-surface systems detect, counter,

	and neutralize ocean deployed mine-like objects.
Subsurface Testing Activities	Various underwater, bottom crawling, robotic vehicles utilized in underwater search, recovery, installation, and scanning activities are tested.
Surface Testing Activities	Various surface vessels, moored equipment, and materials tested to evaluate performance in the marine environment
Unmanned Underwater Vehicle Demonstrations	The performance of multiple unmanned underwater vehicles and associated acoustic, optical, and magnetic systems are tested and demonstrated.

2.2.2.5 ***Additional Activities Outside Naval Sea Systems Command Ranges***

Numerous test activities and technical evaluations in support of Naval Sea Systems Command's systems development mission occur outside the predefined boundaries of the Naval Sea Systems Command's testing ranges and often in conjunction with fleet activities within the Study Area. Tests within this category include, but are not limited to, anti-surface warfare, anti-submarine warfare, and mine warfare tests using torpedoes, sonobuoys, and mine detection and neutralization systems.

Unique Naval Sea Systems Command planned testing includes a kinetic energy weapon, which uses electromagnetic energy to propel a round at a target, and alternative electromagnetic or directed energy devices. In addition, areas of potential increased future equipment and systems testing are swimmer detection systems, lasers, new radars, unmanned vehicles, and chemical-biological detectors.

Table 19. Typical Activities Outside Naval Sea Systems Command Ranges

Additional Activities at Locations Outside of Naval Sea Systems Command Ranges	
Anti-Surface Warfare (ASUW) / Anti-Submarine Warfare (ASW) Testing	
Activity Name	Activity Description
Missile Testing	Missile testing includes various missiles fired from submarines and surface combatants.
Kinetic Energy Weapon Testing	A kinetic energy weapon uses stored energy released in a burst to accelerate a non-explosive projectile.
Electronic Warfare Testing	Testing will include radiation of military and commercial radar and communication systems (or simulators).
Torpedo (Non-Explosive) Testing	Air, surface, or submarine crews employ non-explosive torpedoes against submarines or surface vessels.
Torpedo (Explosive) Testing	Air, surface, or submarine crews employ explosive torpedoes against artificial targets or deactivated ships.
Countermeasure Training	Towed sonar arrays and surface ship torpedo defense systems are employed to detect and neutralize incoming weapons
Pierside Sonar Testing	Pierside testing to ensure systems are fully functional in a controlled pierside environment prior to at-sea test activities.
At-sea Sonar Testing	Sonar systems are tested at sea to ensure they are fully functional in an open ocean environment.
Mine Warfare (MIW) Testing	

Mine Detection and Classification	Air, surface, and subsurface vessels detect and classify mines and mine-like objects.
Mine Countermeasure / Neutralization Testing	Air, surface, and subsurface vessels neutralize threat mines that would otherwise restrict passage through an area.
Shipboard Protection Systems and Swimmer Defense Testing	
Pierside Integrated Swimmer Defense Testing	Swimmer defense testing ensures that systems can effectively detect, characterize, verify, and defend against swimmer/diver threats in harbor environments.
Shipboard Protection Systems Testing	Loudhailers and small-caliber munitions are used to protect a ship against small boat threats.
Chemical / Biological Simulant Testing	Chemical/biological agent simulants are deployed against surface ships.
Unmanned Vehicle Testing	
Underwater Deployed Unmanned Aerial System Testing	Unmanned aerial systems are launched by submarines and special operations forces while submerged.
Unmanned Vehicle Development and Payload Testing	Vehicle development involves the production and upgrade of new unmanned platforms on which to attach various payloads used for different purposes.
Other Testing Activities	
Special Warfare Testing	Special warfare includes testing of submersibles capable of inserting and extracting personnel or payloads into denied areas from strategic distances.
Radio-Frequency Communications Testing	Radio-frequency communications for towed or floating buoys are tested.
Hydrodynamic Testing	Submarines maneuver in the submerged operating environment.
At-Sea Explosives Testing	Explosives are detonated at sea.

2.2.3 Proposed Testing Activity Levels / Naval Air Systems Command

The following table provides a summary of testing activities including tempo and quantities of inert and live munitions that the U.S. plans to expend during testing that were analyzed by the U.S. Navy. Munitions containing high explosives (HE) are bolded in the table to highlight activities that may have greater potential for impacts to listed resources than inert materials.

Table 20. Proposed Naval Air Systems Command Testing Activities (adapted from Table 2.8-2, Alternative 2, U.S. Navy FEIS/OEIS, August 2013, pg. 27)

Range Activity	No. of Events (per Year)	Ordnance (Number per Year)	Location
Anti-Air Warfare (AAW)			
Air Combat Maneuver (ACM)	500	None	AFTT Study Area
Air Platform Vehicle Test	1,477	None	VACAPES
	189	None	JAX
	12	None	Key West
	28	None	GOMEX
	468	None	AFTT Study Area
Air Platform Weapons Integration Test	715	264 missiles, 1,100 rockets, 44,000 medium-caliber projectiles, 440 bombs	VACAPES

Air-to-Air Weapons Systems Test	66	55 missiles, 10,000 medium-caliber projectiles	VACAPES
Air-to-Air Missile Test	83	83 missiles	VACAPES
Air-to-Air Gunnery Test Medium-Caliber	55	9,870 rounds	VACAPES
Intelligence, Surveillance, and Reconnaissance Test	39	None	AFTT Study Area
Anti-Surface Warfare (ASUW)			
Air-to-Surface Missile Test	185	223 missiles (**31 HE**)	VACAPES
	44	65 missiles (18 **HE**)	JAX
	10	10 missiles	GOMEX
Air-to-Surface Gunnery Test – Medium-Caliber	110	44,000 rounds (**11,000 HE**)	VACAPES
	55	44,000 rounds (**11,000 HE**)	JAX
Rocket Test	266	1,189 rockets (**202 HE**)	VACAPES
	66	748 rockets (**202 HE**)	JAX
Air-to-Surface Bombing Test	165	465 bombs	VACAPES
Laser Targeting Test	275	None	VACAPES
	61	None	JAX
High Energy Laser Weapons Test	108	None	VACAPES
Electronic Warfare (EW)			
Electronic System Evaluation	671	None	VACAPES
	21	None	GOMEX
Chaff Test	670	None	VACAPES
	670	None	Cherry Point
	670	None	JAX
	204	None	GOMEX
Flare Test	670	None	VACAPES
	670	None	Cherry Point
	670	None	JAX
	50	None	GOMEX
Anti-Submarine Warfare (ASW)			
ASW Torpedo Test	202	202 torpedoes	VACAPES
	40	45 torpedoes	JAX
Kilo Dip	3	None	Northeast
	35	None	VACAPES
	0	None	Cherry Point
	5	None	JAX
Sonobuoy Lot Acceptance Test	39	**1,512 HE sonobuoys**	Key West
ASW Tracking Test – Helicopter	95	**106 HE sonobuoys**	Northeast
	224	**686 HE sonobuoys**	VACAPES
	0	None	Cherry Point
	83	None	JAX
	26	None	GOMEX
ASW Tracking Test – Maritime Patrol Aircraft	18	**408 HE sonobuoys**	Northeast
	12	**264 HE sonobuoys**	VACAPES
	11	**244 HE sonobuoys**	JAX
	9	**204 HE sonobuoys**	GOMEX

	9	**204 HE sonobuoys**	Cherry Point
	16	**368 HE sonobuoys**	Other AFTT Areas
Airborne Mine Neutralization Systems (AMNS) Test – AQS-235	33	144 neutralizers (**99 HE**)	VACAPES
	0	None	SFOMF
	132	8 mines (**8 HE**), 290 neutralizers (**150 HE**)	NSWC PCD
Airborne Projectile-Based Mine Clearance System	6	120 rounds, 5 mines (**6 HE**)	VACAPES
	231	13,618 rounds, 20 mines (**4 HE**)	NSWC PCD
Airborne Towed Minesweeping Test	33	No HE Mines	VACAPES
	72	8 mines (**4 HE**)	NSWC PCD
Airborne Towed Minehunting Sonar Test	55	None	VACAPES
	100	None	NSWC PCD
	0	None	SFOMF
Airborne Laser-Based Mine Detection System Test	33	None	VACAPES
	121	None	NSWC PCD
Mine Laying Test	6	60 mine shapes	VACAPES
	6	60 mine shapes	JAX
Test and Evaluation (T&E) Catapult Launch	9,570	None	AFTT Study Areas
Air Platform Shipboard Integrate Test	69	None	VACAPES
	33	None	Cherry Point
	33	None	JAX
Shipboard Electronic Systems Evaluation	22	None	VACAPES
	3	None	Cherry Point
	3	None	JAX
Maritime Security	11	None	VACAPES
	11	None	Cherry Point
	11	None	JAX

2.2.4 Proposed Testing Activity Levels / Naval Sea Systems Command

The following table provides a summary of testing activities including tempo and quantities of inert and live munitions that the U.S. plans to expend during testing that were analyzed by the U.S. Navy. The difference in some of the event nomenclature between Table 18 and Table 21 is due to some range activities being recategorized and included as part of the events listed in table 21 as explained in table 2.8-3 of the U.S. Navy Final EIS/OEIS, August 2013.

Table 21. Proposed Naval Sea Systems Command Testing Activities (adapted from Table 2.8-3, Alternative 2, U.S. Navy FEIS/OEIS, August 2013, pg. 29)

Event		No. of Events (per Year)	Ordnance (Number per Year)	Location
Ship Construction and Maintenance				
New Ship Construction				
Surface Combatant Sea Trials	Pierside Sonar Testing	5	None	Pierside: Bath, ME
		3	None	Pierside: Pascagoula, MS
		2	None	Pierside: Norfolk, VA

		2	None	Pierside: Mayport, FL
	Propulsion Testing	5	None	Northeast
		2	None	Gulf of Mexico
		2	None	VACAPES
		2	None	JAX
	Gun Testing	4	104 large-caliber rounds; 2,800 medium-caliber rounds	Northeast
		2	52 large-caliber rounds; 1,400 medium-caliber rounds	Gulf of Mexico
		2	52 large-caliber rounds; 1,400 medium-caliber rounds	VACAPES
		2	52 large-caliber rounds; 1,400 medium-caliber rounds	JAX
	Missile Testing	4	**8 HE missiles**	Northeast
		2	**4 HE missiles**	Gulf of Mexico
		2	**4 HE missiles**	VACAPES
		2	**4 HE missiles**	JAX
	Decoy Testing	4	None	Northeast
		2	None	Gulf of Mexico
		2	None	VACAPES
		2	None	JAX
	Surface Warfare Testing – Large Caliber	4	192 rounds	Northeast
		2	96 rounds	Gulf of Mexico
		2	96 rounds	VACAPES
		2	96 rounds	JAX
	Anti-Submarine Warfare Testing	4	None	Northeast
		2	None	Gulf of Mexico
		2	None	VACAPES
		2	None	JAX
Aircraft Carrier Sea Trials	Propulsion Testing	4 events total	None	VACAPES
	Gun Testing – Small Caliber	100 events total	10,000 rounds total	VACAPES
				Cherry Point
				JAX
	Gun Testing – Medium Caliber	410 events total	67,200 rounds (**600 HE**) Total	VACAPES
				Cherry Point
				JAX
	Missile Testing	17 events total	**17 HE missiles total**	VACAPES
	Bomb Testing	120 events total	240 bombs total	JAX
Submarine Sea Trials	Pierside Sonar Testing	3	None	Pierside: Groton, CT
		3	None	Pierside: Newport News, VA
	Propulsion Testing	4	None	Northeast
		4	None	VACAPES

		4	None	JAX
	Weapons System Testing	4	None	Northeast
		4	None	VACAPES
		4	None	JAX
	Anti-Submarine Warfare Testing	4	None	Northeast
		4	None	VACAPES
		4	None	JAX
Other Class Ship Sea Trials	Propulsion Testing	14	None	AFTT Study Area
		30	None	Gulf of Mexico
		3	None	VACAPES
	Gun Testing – Small Caliber	3	3,000 rounds	VACAPES
		28	28,000 rounds	Gulf of Mexico
ASW Mission Package Testing	Shipboard	16	16 torpedoes	JAX
	Airborne	8	8 torpedoes	VACAPES
SUW Mission Package Testing	Gun Testing – Small Caliber	5	2,500 rounds	AFTT Study Area
	Gun Testing - Medium Caliber	5	7,000 rounds **(3,500 HE rounds)**	AFTT Study Area
	Gun Testing – Large Caliber	5	7,000 rounds **(4,900 HE rounds)**	AFTT Study Area
	Missile/Rocket Testing	15 (either location)	30 missiles/rockets (**15 HE**)	VACAPES
				JAX
MCM Mission Package Testing		8 (either location)	128 neutralizers (**64 HE**)	JAX
				VACAPES
Post Homeporting Testing (All Classes)		4	None	Northeast
		22	None	VACAPES
		22	None	JAX
Shock Trials				
Aircraft Carrier Full Ship Shock Trial		1 event total	4 charges total	VACAPES (Ship Shock Box) / JAX (Ship Shock Box (either location)
DDG 1000 Zumwalt Class Destroyer Full Ship Shock Trial		1 event total	4 charges total	VACAPES (Ship Shock Box) / JAX (Ship Shock Box) (either location)
Littoral Combat Ship Full Ship Shock Trial		2 events total	4 charges per event (8 total)	VACAPES (Ship Shock Box) / JAX (Ship Shock Box) (either location)
Life Cycle Activities				
Ship Signature Testing		2	None	VACAPES
		5	None	Pierside: Little Creek, VA
		2	None	GOMEX
Surface Ship Sonar Testing/Maintenance (in OPAREAs and Ports)		10	None	VACAPES
		6	None	JAX
Submarine Sonar Testing/Maintenance (in OPAREAs and Ports)		12	None	Northeast
		16	None	VACAPES
Combat System Ship Qualification Trial (CSSQT) In Port Maintenance Period		6	None	Pierside: Norfolk, VA
		6	None	Pierside: Mayport,

			FL
Combat System Ship Qualification Trial (CSSQT) – Air Defense (AD)	12	24,000 medium-caliber rounds; 240 large-caliber rounds (**60 HE**); 74 missiles (**38 HE**)	VACAPES
	3	6,000 medium-caliber rounds, 60 large-caliber rounds, 18 missiles (**9 HE**)	JAX
Combat System Ship Qualification Trial (CSSQT) – Surface Warfare (SUW)	15	4,020 large-caliber rounds (**1,737 HE**), 18,000 medium-caliber rounds, 9 missiles	VACAPES
	3	900 large-caliber rounds (**339 HE**), 6,000 medium-caliber rounds, 3 missiles	JAX
	3	900 large-caliber rounds (**339 HE**), 6,000 medium-caliber rounds, 3 missiles	Key West
Combat System Ship Qualification Trial (CSSQT) – Undersea Warfare (USW)	6	48 torpedoes	JAX
	3	24 torpedoes	VACAPES
Naval Sea Systems Command Range Activities			
Naval Surface Warfare Center, Panama City Division Testing Range (NSWC PCD)			
Unmanned Underwater Vehicles Demonstrations	1 event total	None	NSWC PCD
Mine Detection and Classification Testing	81	None	NSWC PCD
Mine Countermeasures / Neutralization Testing	15	**21 HE Charges**	NSWC PCD
Stationary Source Testing	11	None	NSWC PCD
Special Warfare Testing	110	None	NSWC PCD
Unmanned Underwater Vehicle Testing	88	None	NSWC PCD
Ordnance Testing – Line Charge Testing	4	**4 HE Charges**	NSWC PCD
Ordnance Testing – Gun Testing – Small Caliber	7	7,000 rounds	NSWC PCD
Ordnance Testing – Gun Testing – Medium Caliber	102	5,100 rounds	NSWC PCD
Ordnance Testing – Gun Testing – Large Caliber	33	330 rounds (**50 HE**)	NSWC PCD
Naval Undersea Warfare Center Division, Newport Testing Range (NUWCDIVNPT)			
Launcher Testing	39	None	NUWCDIVNPT
Torpedo Testing	30	30 torpedoes	Narragansett Bay and Rhode Island Sound Restricted Areas
Towed Equipment Testing	33	None	NUWCDIVNPT
Unmanned Underwater Vehicle Testing	123	None	NUWCDIVNPT
Unmanned Surface Vehicle Testing	132	None	NUWCDIVNPT
Unmanned Aerial System Testing	17	None	NUWCDIVNPT
Semi-Stationary Equipment Testing	154	None	NUWCDIVNPT

Unmanned Underwater Vehicles Demonstrations	1 event total	None	NUWCDIVNPT
Pierside Integrated Swimmer Defense	6	None	Pierside: Newport, RI
South Florida Ocean Measurement Facility Testing Range (SFOMF)			
Signature Analysis Activities	18	None	SFOMF
Mine Testing Activities	33	None	SFOMF
Surface Testing Activities	33	None	SFOMF
Subsurface Testing Activities	33	None	SFOMF
Unmanned Underwater Vehicles Demonstrations	1 event total	None	SFOMF
Additional Activities at Locations Outside of Naval Sea Systems Command Ranges			
Anti-Submarine Warfare (ASUW) / Anti-Submarine Warfare (ASW) Testing			
Missile Testing	12	12 missiles	VACAPES
	1	1 missile	AFTT Study Area
Kinetic Energy Weapon Testing	55	2,200 projectiles	VACAPES
	1 event total	5,000 projectiles	AFTT Study Area
Electronic Warfare Testing	106	None	Pierside: Norfolk, VA
	106	None	Pierside: Groton, CT
	71	None	Northeast
Torpedo (Non-Explosive) Testing	4	60 torpedoes	Northeast
	13	347 torpedoes	JAX
	3	96 torpedoes	Boston Area Complex: Cape Cod TORPEX boxes
	2	56 torpedoes	Gulf of Mexico
	4	69 torpedoes	VACAPES
Torpedo (Explosive) Testing	2	28 torpedoes (**8 HE**)	AFTT Study Area
Countermeasure Testing	1	None	AFTT Study Area
	2	93 torpedoes	Boston Area Complex: Cape Cod TORPEX boxes/ VACAPES/ GOMEX/ (any location)
Pierside Sonar Testing	2	None	Pierside: Portsmouth, NH
	4	None	Pierside: Groton, CT
	8	None	Pierside: Norfolk, VA
	3	None	Pierside: Kings Bay, GA
	4	None	Pierside: Mayport, FL
	2	None	Pierside: Port Canaveral, FL
At-Sea Sonar Testing	3	None	VACAPES
	5	None	AFTT Study Area
	2	None	Northeast
	5	None	JAX
Mine Warfare (MIW) Testing			
Mine Detection and Classification Testing	8	None	VACAPES

	58	None	JAX
Mine Countermeasures / Neutralization Testing	7	**14 HE Charges**	VACAPES
	7	**14 HE Charges, 7 HE mines**	Gulf of Mexico
Shipboard Protection Systems and Swimmer Defense Testing			
Pierside Integrated Swimmer Defense	3	None	Pierside: Little Creek, VA
Shipboard Protection Systems Testing	4	None	Pierside: Norfolk, VA
	4	1,300 rounds (small caliber)	VACAPES
Chemical / Biological Simulant Testing	968 (in any of the locations)	None	VACAPES
			Northeast
			Cherry Point
			JAX
Unmanned Vehicle Testing			
Underwater Deployed Unmanned Aerial System Testing	30 (either location)	None	VACAPES
		None	Northeast
Unmanned Vehicle Development and Payload Testing	22	None	Northeast
	22	None	VACAPES
	22	None	Cherry Point
	22	None	JAX
	23	None	Gulf of Mexico
Other Testing			
Special Warfare	4	None	Key West
Radio-Frequency Communications Testing	13	None	Northeast
Hydrodynamic Testing	2	None	AFTT Study Area
At-Sea Explosives Testing	4 (either location)	**40 HE Charges**	Gulf of Mexico
			JAX

Understanding the number of munitions detonating in water is critical to assessing potential impacts from acoustic stressors, potential strike and fragments resulting from exploded munitions. Table 22 and Table 23 below provide the number and source of these munitions.

Table 22. Proposed Annual Number of Impulsive Source Detonations During Annual Testing Activities Within the AFTT Study Area

Explosive Class	Net Explosive Weight (NEW)	Annual In-Water Detonations (Testing)
E1	(0.1 lb. – 0.25 lb.)	25,501
E2	(0.26 lb. – 0.5 lb.)	0
E3	(>0.5 lb. – 2.5 lb.)	2,912
E4	(>2.5 lb.-5 lb.)	1,432
E5	(>5 lb.-10 lb.)	495
E6	(>10 lb.-20 lb.)	54
E7	(>20 lb.-60 lb.)	0
E8	(>60 lb.-100 lb.)	11

E9	(>100 lb. – 250 lb.)	0
E10	(>250 lb. – 500 lb.)	10
E11	(>500 lb. – 650 lb.)	27
E12	(>650 lb. – 1,000 lb.)	0
E13	(>1,000 lb. – 1,740 lb.)	0
E14	(>1.740 lb. – 3,625 lb.)	4

Table 23. Proposed Annual Number of Impulsive Source Detonations During Non-Annual Testing Activities Within the AFTT Study Area

Explosive Class	Net Explosive Weight (NEW)	Non-Annual In-Water Detonations (Testing)
E1	(0.1 lb. – 0.25 lb.)	Up to 600
E16	(7,251 lb. – 14,500 lb.)	Up to 12
E17	(14,501 lb. – 58,000 lb.)	Up to 4

Understanding the frequency and duration of active sonar sources is imperative in our risk analysis for stressors resulting from non-impulsive sound sources. Table 24 and Table 25 below provide the annual hours of these sources in the AFTT Study Area.

Table 24. Annual hours and Items of Non-impulsive Sources Used During Annual Testing Within the AFTT Study Area

Source Class Category	Source Class	Annual Use
Low-Frequency (LF) Sources that produce signals less than 1 kHz	LF4	Up to 254 hours
	LF5	Up to 370 hours
	LF6	-
Mid-Frequency (MF) Tactical and non-tactical sources that produce signals from 1 to 10 kHz	MF1	Up to 220 hours
	MF1K	Up to 19 hours
	MF2	Up to 36 hours
	MF3	Up to 434 hours
	MF4	Up to 776 hours
	MF5	Up to 4,184 sonobuoys
	MF6	Up to 303 items
	MF8	Up to 90 hours
	MF9	Up to 13,034 hours
	MF10	Up to 1,067 hours
	MF12	Up to 144 hours
High-Frequency (HF) and Very High-Frequency (VHF): Tactical and non-tactical sources that produce signals greater than 10kHz but less than 200kHz	HF1	Up to 1,243 hours
	HF3	Up to 384 hours

	HF4	Up to 5,572 hours
	HF5	Up to 1,206 hours
	HF6	Up to 1,974 hours
	HF7	Up to 366 hours
Anti-Submarine Warfare (ASW) Tactical sources used during anti-submarine warfare training and testing activities	ASW1	Up to 96 hours
	ASW2	Up to 2,743 sonobouys
	ASW2	Up to 274 hours
	ASW3	Up to 948 hours
	ASW4	Up to 483 items
Torpedoes (TORP) Source classes associated with active acoustic signals produced by torpedoes	TORP1	Up to 581 torpedoes
	TORP2	Up to 521 torpedoes
Acoustic Modems (M) Transmit data acoustically through the water	M3	Up to 461 hours
Swimmer Detection Sonar (SD) Used to detect divers and submerged swimmers	SD1/SD2	Up to 230 hours
Forward Looking Sonar (FLS)	FLS2/FS3	Up to 365 hours
Synthetic Aperture Sonar (SAS): Sonar in which active acoustic signals are post-processed to form high-resolution images of the seafloor	SAS1	Up to 6 hours
	SAS2	Up to 3,424 hours
	SAS3	-

Table 25. Annual hours and Items of Non-impulsive Sources Used During Non-Annual Testing Within the AFTT Study Area

Source Class Category	Source Class	Annual Use
Low-Frequency (LF) Sources that produce signals less than 1 kHz	LF5	Up to 240 hours
Mid-Frequency (MF) Tactical and non-tactical sources that produce signals from 1 to 10 kHz	MF9	Up to 480 hours
High-Frequency (HF) and Very High-Frequency (VHF):	HF5	Up to 240 hours

Tactical and non-tactical sources that produce signals greater than 10kHz but less than 200kHz	HF6	Up to 720 hours
	HF7	Up to 240 hours
Forward Looking Sonar (FLS)	FLS2/FLS3	Up to 240 hours
Synthetic Aperture Sonar (SAS): Sonar in which active acoustic signals are post-processed to form high-resolution images of the seafloor	SAS2	Up to 720 hours

2.2.5 Office of Naval Research and Naval Research Laboratory Testing Activities

As the Department of the Navy's Science and Technology provider, Office of Naval Research and Naval Research Laboratory provide technology solutions for Navy and Marine Corps needs. The Office of Naval Research's mission, defined by law, is to plan, foster, and encourage scientific research in recognition of its paramount importance as related to the maintenance of future naval power, and the preservation of national security.

Further, Office of Naval Research manages the Navy's basic, applied, and advanced research to foster transition from science and technology to higher levels of research, development, test, and evaluation. The Ocean Battlespace Sensing Department explores science and technology in the areas of oceanographic and meteorological observations, modeling, and prediction in the battlespace environment; submarine detection and classification (anti-submarine warfare); and mine warfare applications for detecting and neutralizing mines in both the ocean and littoral environment. The Office of Naval Research events include research, development, test, and evaluation activities; surface processes acoustic communications experiments; shallow water acoustic communications experiments; sediment acoustics experiments; shallow water acoustic propagation experiments; and long-range acoustic propagation experiments.

Table 26. Typical Naval Research Activities

Acoustics Experiments	Description
Martha's Vineyard Coastal Observatory Acoustic Communications Experiment (Coastal)	The Martha's Vineyard Coastal Observatory Acoustic Communications Experiment is designed to investigate ocean surface processes and their role in the generation and evolution of surface bubbles, roughness, and internal turbulence; to investigate the impact of these processes on the propagation of acoustic signals in the ocean; and to test and evaluate different techniques for underwater acoustic communications. Acoustic (active) sources used during the experiments are deployed on bottom-mounted tripods. Passive acoustic receiving arrays (hydrophones) are also deployed on bottom-mounted tripods located at varying distances from the sources. The experiment also involves the use of small scientific acoustic sources that record and measure bubble formation. The data collected will enable scientists to understand more about the effects of bubbles on the propagation of high-frequency sound in shallow water environments. Event duration is one to two weeks.
Sediment Acoustics Experiment (Coastal)	The Sediment Acoustics Experiment is designed to investigate the seasonal variability in seafloor and shallow sub-bottom acoustic properties in shallow water Gulf of Mexico marine environments. The objective is to increase understanding of the variability of seafloor and shallow sub-surface acoustic properties that affect the ability to identify anthropogenic objects in the nearshore environment. The results will enhance understanding of surface and subsurface seafloor geological characteristics, including geo-acoustical and geotechnical properties. Event duration is one to two weeks.

Northwestlant Tomography Experiment (Deep Water)	The primary purpose of Northwestlant Tomography Experiment is to gain an understanding of the behavior of low-frequency sound transmissions in the deep ocean over long distances in areas of naval interest. The experiments combine measurements of acoustic propagation and ambient noise on a vertical line array with the use of an ocean acoustic tomography array to help characterize a complex and highly dynamic region of the ocean. Deep water and long range experiments are designed to collect baseline acoustic and oceanographic data in the Study Area. The experimental active acoustic sources used include phase-coded m-sequence sources at center frequencies of 85 Hz, 230 Hz, and 270 Hz, and a source which will transmit pre-programmed sequences at frequencies in the 10–1,000 Hz band. Event duration is 52 weeks.
East Coast Shallow Water Experiment (Continental Shelf)	The goals of this experiment are to determine the dominant physical processes that affect the acoustic field and to develop decision-making tools for use in shallow water environments. This includes knowing how to choose the relevant environmental parameters to measure, how often to measure them, and how to best select acoustic applications frequencies. Shallow water acoustic experiments aid in meeting the Navy's mission of fully defining the coastal underwater environment and the variables that determine shallow underwater sound transmission. This understanding is important because all users of the ocean environment must rely on acoustic signals to sense their undersea surroundings and to perform the many tasks underwater for which light and other electromagnetic radiation are used in the atmosphere. Underwater sound is used for such basic tasks as measuring ocean depth, locating underwater objects, navigation, and communication. Event duration is one to two weeks.

2.3 Sonar, Ordnance, Targets, and Other Systems Used in Training and Testing

The Navy uses a variety of sensors, platforms, weapons, and other devices to meet its mission. Training and testing with these systems may introduce acoustic (sound) energy into the environment. This section describes and organizes sonar systems, ordnance, munitions, targets, and other systems to facilitate understanding of the activities in which these systems are used. Underwater sound is described as one of two types for the purposes of the Navy's application: impulsive and non-impulsive. Underwater detonations of explosives and other percussive events are impulsive sounds. Sonar and similar sound producing systems are categorized as non-impulsive sound sources.

2.3.1 Sonar and Other Non-impulsive Sources

Modern sonar technology includes a variety of sonar sensor and processing systems. The simplest active sonar emits sound waves, or "pings," sent out in multiple directions and the sound waves then reflect off of the target object in multiple directions. The sonar source calculates the time it takes for the reflected sound waves to return; this calculation determines the distance to the target object. More sophisticated active sonar systems emit a ping and then rapidly scan or listen to the sound waves in a specific area. This provides both distance to the target and directional information. Even more advanced sonar systems use multiple receivers to listen to echoes from several directions simultaneously and provide efficient detection of both direction and distance. The Navy rarely uses active sonar continuously throughout activities. When sonar is in use, the pings occur at intervals, referred to as a duty cycle, and the signals themselves are very short in duration. For example, sonar that emits a 1-second ping every 10 seconds has a 10-percent duty cycle. The Navy utilizes sonar systems and other acoustic sensors in support of a variety of mission requirements. Primary uses include the detection of and defense against submarines (anti-submarine warfare) and mines (mine warfare); safe navigation and effective communications; use of unmanned undersea vehicles; and oceanographic surveys.

2.3.2 **Ordnance and Munitions**

Most ordnance and munitions used during training and testing events fall into three basic categories: projectiles (such as gun rounds), missiles (including rockets), and bombs. Ordnance can be further defined by their net explosive weight, which considers the type and quantity of the explosive substance without the packaging, casings, bullets, etc. Net explosive weight (NEW) is the trinitrotoluene (TNT) equivalent of energetic material, which is the standard measure of strength of bombs and other explosives. For example, a 12.7-centimeter (cm) shell fired from a Navy gun is analyzed at about 9.5 pounds (lb) (4.3 kilograms (kg)) of NEW. The Navy also uses non-explosive ordnance in place of high explosive ordnance in many training and testing events. Non-explosive ordnance munitions look and perform similarly to high explosive ordnance, but lack the main explosive charge.

2.3.3 **Defense Countermeasures**

Naval forces depend on effective defensive countermeasures to protect themselves against missile and torpedo attack. Defensive countermeasures are devices designed to confuse, distract, and confound precision guided munitions. Defensive countermeasures analyzed in this opinion include acoustic countermeasures, which are used by surface ships and submarines to defend against torpedo attack. Acoustic countermeasures are either released from ships and submarines, or towed at a distance behind the ship.

2.3.4 **Mine Warfare Systems**

The Navy divides mine warfare systems into two categories: mine detection and mine neutralization. Mine detection systems are used to locate, classify, and map suspected mines, on the surface, in the water column, or on the sea floor. The Navy analyzed the following mine detection systems for potential impacts to marine mammals:

- Towed or hull-mounted mine detection systems. These detection systems use acoustic and laser or video sensors to locate and classify suspect mines. Fixed and rotary wing platforms, ships, and unmanned vehicles are used for towed systems, which can rapidly assess large areas.

- Unmanned/remotely operated vehicles. These vehicles use acoustic and video or lasers to locate and classify mines and provide unique capabilities in nearshore littoral areas, surf zones, ports, and channels.

- Marine mammal systems. The Navy deploys trained Atlantic bottlenose dolphins (*Tursiops truncatus*) and California sea lions (*Zalopus californianus*) for integrated training involving two primary mission areas: to find objects such as inert mine shapes, and to detect swimmers or other intruders around Navy facilities such as piers. These systems also include one or more motorized small boats and several crew members for each trained marine mammal.

When not engaged in training, Navy marine mammals are housed in temporary enclosures either on land or aboard ships.

2.3.5 Mine Neutralization Systems

Mine neutralization systems disrupt, disable, or detonate mines to clear ports and shipping lanes, as well as littoral, surf, and beach areas in support of naval amphibious operations. The Navy analyzed the following mine neutralization systems for potential impacts to marine mammals:

- Towed influence mine sweep systems. These systems use towed equipment that mimic a particular ship's magnetic and acoustic signature triggering the mine and causing it to explode.

- Unmanned/remotely operated mine neutralization systems. Surface ships and helicopters operate these systems, which place explosive charges near or directly against mines to destroy the mine.

- Airborne projectile-based mine clearance systems. These systems neutralize mines by firing a small or medium-caliber non-explosive, supercavitating projectile from a hovering helicopter.

- Diver emplaced explosive charges. Operating from small craft, divers put explosive charges near or on mines to destroy the mine or disrupt its ability to function.

2.3.6 Classification of Non-impulsive and Impulsive Sources Analyzed

In order to better organize and facilitate the analysis of about 300 sources of underwater non-impulsive sound or impulsive energy, the Navy developed a series of source classifications, or source bins. This method of analysis provides the following benefits:

- Allows for new sources to be covered under existing authorizations, as long as those sources fall within the parameters of a "bin;"

- Simplifies the data collection and reporting requirements anticipated under the MMPA;

- Ensures a conservative approach to all impact analysis because all sources in a single bin are modeled as the loudest source (e.g., lowest frequency, highest source level, longest duty cycle, or largest net explosive weight within that bin);

- Allows analysis to be conducted more efficiently, without compromising the results;

- Provides a framework to support the reallocation of source usage (hours/explosives) between different source bins, as long as the total number and severity of marine mammal takes remain within the overall analyzed and authorized limits. This flexibility is required to support evolving Navy training and testing requirements, which are linked to real world events.

Non-impulsive sources are grouped into bins based on the frequency, source level when warranted, and how the source would be used. Impulsive bins are based on the net explosive weight of the munitions or explosive devices. The following factors further describe how non-impulsive sources are divided:

- Frequency of the non-impulsive source:
  - Low-frequency sources operate below 1 kilohertz (kHz)
  - Mid-frequency sources operate at or above 1 kHz, up to and including 10 kHz
  - High-frequency sources operate above 10 kHz, up to and including 100 kHz
  - Very high-frequency sources operate above 100 kHz, but below 200 kHz
- Source level of the non-impulsive source:
  - Greater than 160 decibels (dB), but less than 180 dB
  - Equal to 180 dB and up to 200 dB
  - Greater than 200 dB

How a sensor is used determines how the sensor's acoustic emissions are analyzed. Factors to consider include pulse length (time source is on); beam pattern (whether sound is emitted as a narrow, focused beam, or, as with most explosives, in all directions); and duty cycle (how often a transmission occurs in a given time period during an event).

There are also non-impulsive sources with characteristics that are not anticipated to result in takes of marine mammals. These sources have low source levels, narrow beam widths, downward directed transmission, short pulse lengths, frequencies beyond known hearing ranges of marine mammals, or some combination of these factors. These sources were not modeled by the Navy, but are qualitatively analyzed in the AFTT FEIS/OEIS.

2.3.7 U.S. Navy Proposed Mitigation and Monitoring – Standard Operating Procedures

This section describes the Navy's standard operating procedures, mitigation measures, and marine species monitoring and reporting efforts that were developed in close coordination with NMFS' Office of Protected Resources based previous consultations and lessons-learned from employment during Phase I (2008-2013) training and testing activities activities. Table 27 provides a summary of the Navy's proposed mitigation measures. These measures are also described in NMFS' proposed final rule in this opinion. The measures presented in the table are discussed in greater detail in Section 5.3.1 (Lookout Procedural Measures), Section 5.3.2 (Mitigation Zone Procedural Measures), and Section 5.3.3 (Mitigation Areas) of the FEIS/OEIS.

Table 27. Summary of the U.S. Navy's Proposed Mitigation and Monitoring Measures

Activity Category or Mitigation Area	Recommended Lookout Procedural Measure	Recommended Mitigation Zone and Protection Focus	Current Measure and Protection Focus
Specialized Training	Lookouts will complete the Introduction to the U.S. Navy Afloat Environmental Compliance Training Series and the U.S. Navy Marine Species Awareness Training or civilian equivalent	The mitigation zones observed by Lookouts are specified for each Mitigation Zone Procedural Measure below.	The mitigation zones observed by Lookouts are specified for each Mitigation Zone Procedural Measure below.
Low-Frequency and Hull-Mounted Mid-Frequency Active Sonar during Anti-Submarine Warfare and Mine Warfare	2 Lookouts (general) 1 Lookout (minimally manned, moored, or anchored)	Sources that can be powered down: 1,000 yd (914 m) and 500 yd (457 m) power downs and 200 yd (183 m) shutdown for marine mammals (hull-mounted mid-frequency and low-frequency) and sea turtles (low-frequency only). Sources that cannot be powered down: 200 yd (183 m) shutdown for marine mammals and sea turtles. Both: observation for concentrations of floating vegetation (*Sargassum* or kelp paddies).	Hull-mounted mid-frequency: 1,000 yd. (914 m) and 500 yd. (457 m) power downs and 200 yd. (183 m) shutdown for marine mammals and sea turtles; avoidance of *Sargassum* rafts. Low-frequency: None
High-Frequency and Non-Hull Mounted Mid-Frequency Active Sonar	1 Lookout	200 yd. (183 m) for marine mammals (high-frequency and mid-frequency), sea turtles (bins MF8, MF9, MF10, and MF12 only), and concentrations of floating vegetation (*Sargassum* or kelp paddies).	Non-hull mounted mid-frequency: 200 yd. (183 m) for marine mammals, floating vegetation, and kelp paddies. High-frequency: None
Improved Extended Echo Ranging Sonobuoys	1 Lookout	600 yd. (549 m) for marine mammals, sea turtles, and concentrations of floating	1,000 yd. (914 m) for marine mammals and sea turtles; 400 yd. (366 m) for floating vegetation

		vegetation (*Sargassum* or kelp paddies). Passive acoustic monitoring conducted with Navy assets participating in the activity.	and kelp paddies. Passive acoustic monitoring conducted with Navy assets participating in the activity.
Explosive Sonobuoys Using 0.6–2.5 Pound NEW	1 Lookout	350 yd. (320 m) for marine mammals, sea turtles, and concentrations of floating vegetation (*Sargassum* or kelp paddies). Passive acoustic monitoring conducted with Navy assets participating in the activity.	None
Anti-Swimmer Grenades	1 Lookout	200 yd. (183 m) for marine mammals, sea turtles, and concentrations of floating vegetation (*Sargassum* or kelp paddies).	200 yd. (183 m) for marine mammals, sea turtles, floating vegetation, and kelp paddies.
Mine Countermeasure and Neutralization Activities Using Positive Control Firing Devices	General: 1 or 2 Lookouts (NEW dependent) Diver-placed: 2 Lookouts Protective Measures Assessment Protocol will contain maps of surveyed shallow coral reefs, artificial reefs, shipwrecks, and live hardbottom.	Both: NEW dependent for marine mammals, sea turtles, and concentrations of floating vegetation (*Sargassum* or kelp paddies). Both: 350 yd. (320 m) from surveyed shallow coral reefs, live hardbottom, artificial reefs, and shipwrecks. Both: 1 nm from beach in the VACAPES Range Complex and 3,000 ft. (914 m) around Fisherman Island for birds. Diver-placed: 3.2 nm from an estuarine inlet and 1.6 nm from shoreline within the Navy Cherry Point Range Complex for sea turtles.	General: NEW dependent for marine mammals and sea turtles. Diver-placed: 700 yd. (640 m) for up to 20 lb. NEW for marine mammals and turtles. Both: 1,000 ft. (305 m) from surveyed live hardbottom, artificial reefs, and shipwrecks. Both: 1 nm from beach and 3,000 ft. (914 m) around Fisherman Island in the VACAPES Range Complex for birds. Diver-placed: 3.2 nm from estuarine inlet and 1.6 nm from shoreline in VACAPES, Navy Cherry Point, and JAX Range Complexes for sea turtles.

Mine Neutralization Activities Using Diver-Placed Time-Delay Firing Devices	4 Lookouts Protective Measures Assessment Protocol will contain maps of surveyed shallow coral reefs, artificial reefs, shipwrecks, and live hardbottom.	Up to 10 min. time-delay using up to 20 lb. NEW: 1,000 yd. (915 m) for marine mammals, sea turtles, and concentrations of floating vegetation (*Sargassum* or kelp paddies). 350 yd. (320 m) for surveyed shallow coral reefs, live hardbottom, artificial reefs, and shipwrecks. 1 nm from beach in the VACAPES Range Complex and 3,000 ft. (914 m) around Fisherman Island for birds. 3.2 nm from an estuarine inlet and 1.6 nm from shoreline within the Navy Cherry Point Range Complex for sea turtles.	10 min. time-day on 20 lb. NEW: 1,450 yd. (1.3 km) for marine mammals and sea turtles.
Explosive and Non-Explosive Gunnery Exercises – Small- and Medium-Caliber Using a Surface Target	1 Lookout Protective Measures Assessment Protocol will contain maps of surveyed shallow coral reefs.	200 yd. (183 m) for marine mammals, sea turtles, and concentrations of floating vegetation (*Sargassum* or kelp paddies). 350 yd. (320 m) for surveyed shallow coral reefs.	200 yd. (183 m) for marine mammals, sea turtles, floating vegetation, and surveyed shallow coral reefs.
Explosive and Non-Explosive Gunnery Exercises – Large-Caliber Using a Surface Target	1 Lookout Protective Measures Assessment Protocol will contain maps of surveyed shallow coral reefs.	Explosive: 600 yd. (549 m) for marine mammals, sea turtles, and concentrations of floating vegetation (*Sargassum* or kelp paddies). Non-Explosive: 200 yd. (183 m) for marine mammals, sea turtles, and concentrations of floating vegetation (*Sargassum* or kelp paddies). Both: 70 yd. (64 m) within 30	Explosive: 600 yd. (549 m) for marine mammals, sea turtles, floating vegetation, and surveyed shallow coral reefs. Non-Explosive: 200 yd. (183 m) for marine mammals, sea turtles, and concentrations of floating vegetation (*Sargassum* or kelp paddies). Both: 70 yd. (64 m) around entire ship for marine mammals and sea

		degrees on either side of the gun target line on the firing side for marine mammals, sea turtles, and concentrations of floating vegetation (*Sargassum* or kelp paddies). Both: 350 yd. (320 m) for surveyed shallow coral reefs.	turtles.
Non-Explosive Missile Exercises and Explosive Missile Exercises (Including Rockets) up to 250 Pound NEW Using a Surface Target	1 Lookout Protective Measures Assessment Protocol will contain maps of surveyed shallow coral reefs.	900 yd. (823 m) for marine mammals, sea turtles, and concentrations of floating vegetation (*Sargassum* or kelp paddies). 350 yd. (320 m) for surveyed shallow coral reefs.	1,800 yd. (1.6 km) for marine mammals, sea turtles, floating vegetation, and kelp paddies.
Explosive Missile Exercises Using 251–500 Pound NEW Using a Surface Target	1 Lookout Protective Measures Assessment Protocol will contain maps of surveyed shallow coral reefs.	2,000 yd. (1.8 km) for marine mammals, sea turtles, and concentrations of floating vegetation (*Sargassum* or kelp paddies). 350 yd. (320 m) for surveyed shallow coral reefs.	None
Explosive and Non-Explosive Bombing Exercises	1 Lookout Protective Measures Assessment Protocol will contain maps of surveyed shallow coral reefs.	Explosive: 2,500 yd. (2.3 km) for marine mammals, sea turtles, and concentrations of floating vegetation (*Sargassum* or kelp paddies). Non-Explosive: 1,000 yd. (914 m) for marine mammals, sea turtles, and concentrations of floating vegetation (*Sargassum* or kelp paddies). Both: 350 yd. (320 m) for surveyed shallow coral reefs.	Explosive: 5,100 yd. (4.7 km) for marine mammals, sea turtles, and floating vegetation. Non-Explosive: 1,000 yd. (914 m) for marine mammals, sea turtles, floating vegetation, and kelp paddies.
Torpedo (Explosive) Testing	1 Lookout	2,100 yd. (1.9 km) for marine mammals, sea turtles,	5,063 yd. (4.6 km) for marine mammals, sea turtles, floating

		concentrations of floating vegetation (*Sargassum* or kelp paddies), and jellyfish aggregations. Passive acoustic monitoring conducted with Navy assets participating in the activity.	vegetation, and jellyfish aggregations. Passive acoustic monitoring conducted with Navy assets participating in the activity.
Sinking Exercises	2 Lookouts	2.5 nm for marine mammals, sea turtles, concentrations of floating vegetation (*Sargassum* or kelp paddies), and jellyfish aggregations. Passive acoustic monitoring conducted with Navy assets participating in the activity.	4.5 nm for marine mammals and sea turtles. 2.5 nm for floating vegetation and jellyfish aggregations. Passive acoustic monitoring conducted with Navy assets participating in the activity.
At-Sea Explosive Testing	1 Lookout Protective Measures Assessment Protocol will contain maps of surveyed shallow coral reefs.	1,600 yd. (1.4 km) for marine mammals, sea turtles, and concentrations of floating vegetation (*Sargassum* or kelp paddies). 350 yd. (320 m) for surveyed shallow coral reefs.	None
Ordnance Testing – Line Charge Testing	1 Lookout	900 yd. (823 m) for marine mammals, sea turtles, and concentrations of floating vegetation (*Sargassum* or kelp paddies).	880 yd. (805 m) for marine mammals and sea turtles. 0.5 mi. (0.8 km) for Gulf sturgeon.
Ship Shock Trials	At least 10 Lookouts or trained marine species observers (or combination)	10,000-lb. and 40,000-lb. charge: 3.5 nm for all locations for marine mammals, sea turtles, concentrations of floating vegetation (*Sargassum* or kelp paddies), jellyfish aggregations, large schools of fish, and flocks of seabirds.	10,000-lb. charge: 3 nm/3.5 nm for VACAPES / JAX for marine mammals, sea turtles, floating vegetation, jellyfish aggregations, large schools of fish, and flocks of seabirds. 40,000-lb. charge: None.
Vessel Movements	1 Lookout	500 yd. (457 m) for whales.	500 yd. (457 m) for whales.

		200 yd. (183 m) for all other marine mammals (except bow riding dolphins).	200 yd. (183 m) for all other marine mammals (except bow riding dolphins).
Towed In-Water Device Use	1 Lookout	250 yd. (229 m) for marine mammals.	250 yd. (229 m) for marine mammals.
Precision Anchoring	No Lookouts in addition to standard personnel standing watch Protective Measures Assessment Protocol will contain maps of surveyed shallow coral reefs, artificial reefs, shipwrecks, and live hardbottom	Avoidance of precision anchoring within the anchor swing diameter of surveyed shallow coral reefs, live hardbottom, artificial reefs, and shipwrecks.	Avoidance of precision anchoring within the anchor watch circle diameter of surveyed shallow coral reefs, live hardbottom, artificial reefs, and shipwrecks.
North Atlantic Right Whale Calving Habitat off the Southeast United States	Activity-specific measures described in the Lookout Procedural Measures and Mitigation Zone Procedural Measures	Avoidance or minimization of conduct of specific activities seasonally. Use Early Warning System sightings data.	Avoidance or minimization of conduct of specific activities seasonally. Use Early Warning System sightings data.
North Atlantic Right Whale Foraging Habitat off the Northeast	3 Lookouts during torpedo (non-explosive) testing activities All other activity-specific measures described in the Lookout Procedural Measures and Mitigation Zone Procedural Measures	Avoidance or minimization of conduct of specific activities seasonally. Use Sighting Advisory System sightings data. Specific measures for torpedo (non-explosive) testing activities year-round.	Avoidance or minimization of conduct of specific activities seasonally. Use Sighting Advisory System sightings data. Conduct torpedo (non-explosive) testing activities in five designated areas seasonally. Submit written requests prior to conducting hull-mounted surface and submarine active sonar training or helicopter dipping in the mitigation area.
North Atlantic Right Whale Mid-Atlantic Migration Corridor	1 Lookout	Practice increased vigilance, exercise extreme caution, and proceed at the slowest speed that is consistent with safety, mission, and training and testing objectives.	Practice increased vigilance, exercise extreme caution, and proceed at the slowest speed that is consistent with safety, mission, and training and testing objectives.

West Indian Manatee Habitat	Activity-specific measures described in the Lookout Procedural Measures and Mitigation Zone Procedural Measures	Mayport, Florida: Comply with all federal, state, and local Manatee Protection Zones; sightings communication. Port Canaveral, Florida: Pierside sonar observations and sightings communication. Kings Bay, Georgia: Pierside sonar observations and sightings communication.	Mayport, Florida: Comply with all federal, state, and local Manatee Protection Zones; sightings communication. Port Canaveral, Florida: Pierside sonar observations and sightings communication. Kings Bay, Georgia: Pierside sonar observations and sightings communication. Camp Lejeune, North Carolina: None
Planning Awareness Areas	Activity-specific measures described in the Lookout Procedural Measures and Mitigation Zone Procedural Measures	Limit planning major active sonar exercises.	Limit planning major active sonar exercises.
Shallow Coral Reefs, Hardbottom Habitat, Artificial Reefs, and Shipwrecks	No Lookouts in addition to standard personnel standing watch Protective Measures Assessment Protocol will contain maps of surveyed shallow coral reefs, artificial reefs, shipwrecks, and live hardbottom	No precision anchoring within the anchor swing diameter and no explosive mine countermeasure and neutralization activities within 350 yd. (320 m) of surveyed shallow coral reefs, live hardbottom, artificial reefs, and shipwrecks. No explosive or non-explosive small-, medium-, and large-caliber gunnery exercises using a surface target; explosive or non-explosive missile exercises using a surface target; explosive or non-explosive bombing exercises; or at-sea explosive testing within 350 yd. (320 m) of surveyed shallow coral reefs.	Varying mitigation zone distances based on marine mammal ranges to effects.
Live Hardbottom and Shallow	No Lookouts in addition to	Anchors and Mine-like Objects:	Anchors and Mine-like Objects:

Coral Reefs within South Florida Ocean Measurement Facility	standard personnel standing watch Protective Measures Assessment Protocol will contain maps of surveyed shallow coral reefs and live hardbottom	Installation of anchors and mine-like objects are conducted using real-time GIS and GPS, along with groundtruth and verification support, which will help the Navy avoid sensitive marine species and communities during deployment, installation, and recovery. Bottom Crawling Unmanned Underwater Vehicles: If deployment occurs greater than 9.8 ft. (3 m) in depth, it will be conducted using real-time GIS and GPS, along with groundtruth and verification support, which will help the Navy avoid sensitive marine species and communities.	Installation of anchors and mine-like objects are conducted using real-time GIS and GPS, along with groundtruth and verification support, which will help the Navy avoid sensitive marine species and communities during deployment, installation, and recovery. Bottom Crawling Unmanned Underwater Vehicles: None
Sea Turtle Nesting Habitat	Activity-specific measures described in the Lookout Procedural Measures and Mitigation Zone Procedural Measures	Naval Surface Warfare Center, Panama City Division: Sea turtle nesting season is defined as from March through September; Avoidance of ordnance testing – line charge testing activities during the night during nesting season. Navy Cherry Point Range Complex: Positive control and time-delay diver-placed mine neutralization and countermeasure activities remain 3.2 nm from estuarine inlets and 1.6 nm from shoreline from March through September.	Naval Surface Warfare Center, Panama City Division: Sea turtle nesting season is defined as from May through September; Avoidance of electromagnetic mine countermeasure and neutralization activities within 32 yd. (30 m) of shore during nesting season; Avoidance of ordnance testing – line charge testing activities (day and night) during nesting season. VACAPES, Navy Cherry Point, and JAX Range Complexes: Positive control diver-placed mine neutralization and countermeasure activities remain

			3.2 nm from estuarine inlets and 1.6 nm from shoreline.
Piping Plover Habitat in Virginia	Activity-specific measures described in the Lookout Procedural Measures and Mitigation Zone Procedural Measures	1 nm from beach in VACAPES Range Complex and 3,000 ft. (914 m) around Fisherman Island during positive control and time-delay diver-placed mine neutralization and countermeasure activities.	1 nm from beach in VACAPES Range Complex and 3,000 ft. (914 m) around Fisherman Island during positive control diver-placed mine neutralization and countermeasure activities.
Gulf Sturgeon Habitat in the Gulf of Mexico	Activity-specific measures described in the Lookout Procedural Measures and Mitigation Zone Procedural Measures	No ordnance testing – line charge testing activities will occur within nearshore Gulf of Mexico waters in Escambia, Santa Rosa, Okaloosa, Walton, Bay, and Gulf counties in Florida from the shoreline to 1 mi. (1.6 km) offshore between October and March (except within the designated line charge testing location on Santa Rosa Island).	No ordnance testing – line charge testing activities will occur within nearshore Gulf of Mexico waters in Escambia, Santa Rosa, Okaloosa, Walton, Bay, and Gulf counties in Florida from the shoreline to 1 mi. (1.6 km) offshore between October and March.

2.4 Scope of NMFS Permits Division's Proposed MMPA Rule and Letters of Authorization

On 13 April 2012, NMFS' Permits Division received an application from the U.S. Navy requesting regulations and two LOAs for the take of 42 species of marine mammals incidental to Navy training and testing activities to be conducted in the AFTT Study Area over 5 years. The Navy submitted addendums on 24 September 2012 and 21 December 2012.

The Permits Division proposes (1) to promulgate a rule pursuant to the Marine Mammal Protection Act (MMPA) and (2) to issue two Letters of Authorization (LOA) for U.S. Navy Atlantic Fleet Training and Testing activities respectively. While the MMPA Rule establishes the framework, the LOA would actually authorize "take" of marine mammals including those that are listed as threatened or endangered incidental to U.S. Navy training and testing activities.

2.4.1 Proposed Marine Mammal Protection Act (MMPA) Regulations for U.S. Navy Atlantic Fleet Training and Testing for November 2013 through November 2018

NMFS Permits Division's proposed final rule is based on the information contained in the revised LOA applications. The Navy is requesting regulations that would establish a process for authorizing take, via two separate 5-year LOAs, of marine mammals for training activities and for testing activities, each proposed to be conducted from Novemeber 2013 through November 2018.

Marine mammals present in the Study Area may be exposed to sound from active sonar and underwater detonations. In addition, incidental takes of marine mammals may occur from ship strikes. The Navy requests authorization to take individuals of 42 marine mammal species by Level B harassment and individuals of 32 marine mammal species by Level A harassment. In addition, the Navy requests authorization for take by serious injury or mortality individuals of 16 marine mammal species due to the use of explosives, and 11 total marine mammals (any species except North Atlantic right whale) over the course of the proposed 5-year rule due to vessel strike.

There are nine marine mammal species under NMFS jurisdiction included in the Navy's incidental take authorization request that are listed as threatened or endangered under the ESA with confirmed or possible occurrence in the Study Area. They are: blue whale, humpback whale, fin whale, sei whale, sperm whale, North Atlantic right whale, and ringed seal – Arctic DPS. We are consulting with NMFS' Permits Division pursuant to section 7 of the ESA, on the issuance of the proposed rule and draft LOAs under section 101(a)(5)(A) of the MMPA for AFTT activities. We have also determined that NMFS Permit Division's actions are interdependent with the U.S. Navy Atlantic Fleet's proposed testing and training (i.e., AFTT). Therefore, both actions are assessed in this Opinion. The proposed rule provides a five-year framework for authorizations including descriptions of the specified activity and specified geographical region (Sec. 218.80), effective dates and definitions (Sec. 218.81), permissible methods of taking (Sec. 218.82), prohibitions (Sec. 218.83), mitigation (Sec. 218.84), requirements for monitoring and reporting (Sec. 218.85), and procedures for applications for letters of authorization (Sec. 218.86), issuance of letters of authorization (Sec. 218.87), and Renewals and Modifications of Letters of Authorization and Adaptive Management (Sec. 218.88).

The proposed rule amends 50 CFR §218 with regard to the taking and importing marine mammals; U.S. Navy's Atlantic Fleet Training and Testing (AFTT). We provide excerpts from the description of the activity (anticipated levels of activities), permissible methods of taking and mitigation for the five-year period.

§ 218.80 Specified activity and specified geographical region.

(c) The taking of marine mammals by the Navy is only authorized if it occurs incidental to the following activities :

- (1) Active Acoustic Sources Used During Annual Training:
    - (i) Mid-frequency (MF) Source Classes:
        - (A) MF1 – an average of 9,844 hours per year.
        - (B) MF1K – an average of 163 hours per year.
        - (C) MF2 – an average of 3,150 hours per year.
        - (D) MF2K – an average of 61 hours per year.
        - (E) MF3 – an average of 2,058 hours per year.
        - (F) MF4 – an average of 927 hours per year.
        - (G) MF5 – an average of 14,556 sonobuoys per year.
        - (H) MF11 – an average of 800 hours per year.
        - (I) MF12 – an average of 687 hours per year.
    - (ii) High-frequency (HF) and Very High-frequency (VHF) Source Classes:
        - (A) HF1 – an average of 1,676 hours per year.
        - (B) HF4 – an average of 8,464 hours per year.
    - (iii) Anti-Submarine Warfare (ASW) Source Classes:
        - (A) ASW1 – an average of 128 hours per year.
        - (B) ASW2 – an average of 2,620 sonobuoys per year.
        - (C) ASW3 – an average of 13,586 hours per year.
        - (D) ASW4 – an average of 1,365 devices per year.
    - (iv) Torpedoes (TORP) Source Classes:
        - (A) TORP1 – an average of 54 torpedoes per year.
        - (B) TORP2 – an average of 80 torpedoes year.
- (2) Active Acoustic Sources Used During Annual Testing:
    - (i) LF:
        - (A) LF4 – an average of 254 hours per year.
        - (B) LF5 – an average of 370 hours per year.
    - (ii) MF:
        - (A) MF1 – an average of 220 hours per year.
        - (B) MF1K – an average of 19 hours per year.
        - (C) MF2 – an average of 36 hours per year.
        - (D) MF3 – an average of 434 hours per year.
        - (E) MF4 – an average of 776 hours per year.
        - (F) MF5 – an average of 4,184 sonobuoys per year.
        - (G) MF6 – an average of 303 items per year.
        - (H) MF8 – an average of 90 hours per year.

(I) MF9 – an average of 13,034 hours per year.
(J) MF10 – an average of 1,067 hours per year.
(K) MF12 – an average of 144 hours per year.
(iii) HF and VHF:
(A) HF1 – an average of 1,243 hours per year.
(B) HF3 – an average of 384 hours per year.
(C) HF4 – an average of 5,572 hours per year.
(D) HF5 – an average of 1,206 hours per year.
(E) HF6 – an average of 1,974 hours per year.
(F) HF7 – an average of 366 hours per year.
(iv) ASW:
(A) ASW1 – an average of 96 hours per year.
(B) ASW2 – an average of 2,743 sonobuoys per year.
(C) ASW2 – an average of 274 hours per year.
(D) ASW3 – an average of 948 hours per year.
(E) ASW4 – an average of 483 devices per year.
(v) TORP:
(A) TORP1 – an average of 581 torpedoes per year.
(B) TORP2 – an average of 521 torpedoes per year.
(vi) Acoustic Modems (M):
(A) M3 – an average of 461 hours per year.
(B) [Reserved]
(vii) Swimmer Detection Sonar (SD):
(A) SD1 and SD2 – an average of 230 hours per year.
(B) [Reserved]
(viii) Forward Looking Sonar (FLS):
(A) FLS2 and FLS3 – an average of 365 hours per year.
(B) [Reserved]
(ix) Synthetic Aperture Sonar (SAS):
(A) SAS1 – an average of 6 hours per year.
(B) SAS2 – an average of 3,424 hours per year.
(3) Explosive Sources Used During Annual Training:
(i) Explosive Classes:
(A) E1 (0.1 to 0.25 lb NEW) – an average of 124,552 detonations per year.
(B) E2 (0.26 to 0.5 lb NEW) – an average of 856 detonations per year.
(C) E3 (>0.5 to 2.5 lb NEW) – an average of 3,132 detonations per year.
(D) E4 (>2.5 to 5 lb NEW) – an average of 2,190 detonations per year.
(E) E5 (>5 to 10 lb NEW) – an average of 14,370 detonations per year.
(F) E6 (>10 to 20 lb NEW) – an average of 500 detonations per year.
(G) E7 (>20 to 60 lb NEW) – an average of 322 detonations per year.
(H) E8 (>60 to 100 lb NEW) – an average of 77 detonations per year.
(I) E9 (>100 to 250 lb NEW) – an average of 2 detonations per year.
(J) E10 (>250 to 500 lb NEW) – an average of 8 detonations per year.
(K) E11 (>500 to 650 lb NEW) – an average of 1 detonations per year.
(L) E12 (>650 to 1,000 lb NEW) – an average of 133 detonations per year.

(ii) [Reserved]
(4) Explosive Sources Used During Annual Testing:
(i) Explosive Classes:
(A) E1 (0.1 to 0.25 lb NEW) – an average of 25,501 detonations per year.
(B) E2 (0.26 to 0.5 lb NEW) – an average of 0 detonations per year.
(C) E3 (>0.5 to 2.5 lb NEW) – an average of 2,912 detonations per year.
(D) E4 (>2.5 to 5 lb NEW) – an average of 1,432 detonations per year.
(E) E5 (>5 to 10 lb NEW) – an average of 495 detonations per year.
(F) E6 (>10 to 20 lb NEW) – an average of 54 detonations per year.
(G) E7 >20 to 60 lb NEW) – an average of 0 detonations per year.
(H) E8 (>60 to 100 lb NEW) – an average of 11 detonations per year.
(I) E9 (>100 to 250 lb NEW) – an average of 0 detonations per year.
(J) E10 (>250 to 500 lb NEW) – an average of 10 detonations per year.
(K) E11 (>500 to 650 lb NEW) – an average of 27 detonations per year.
(L) E12 (>650 to 1,000 lb NEW) – an average of 0 detonations per year.
(M) E13 (>1,000 to 1,740 lb NEW) – an average of 0 detonations per year.
(N) E14 (>1,714 to 3,625 lb NEW) – an average of 4 detonations per year.
(ii) [Reserved]
(5) Active Acoustic Source Used During Non-Annual Training
(i) HF4 – an average of 192 hours
(ii) [Reserved]
(6) Active Acoustic Sources Used During Non-Annual Testing
(i) LF5 – an average of 240 hours
(ii) MF9 – an average of 480 hours
(iii) HF5 – an average of 240 hours
(iv) HF6 – an average of 720 hours
(v) HF7 – an average of 240 hours
(vi) FLS2 and FLS3 – an average of 240 hours
(vii) SAS2 – an average of 720 hours
(7) Explosive Sources Used During Non-Annual Training
(i) E2 (0.26 to 0.5 lbs NEW) – an average of 2
(ii) E4 (2.6 to 5 lbs NEW) – an average of 2
(8) Explosive Sources Used During Non-Annual Testing
(i) E1 (0.1 to 0.25 lbs NEW) – an average of 600
(ii) E16 (7,251 to 14,500 lbs NEW) – an average of 12
(iii) E17 (14,501 to 58,000 lbs NEW) – an average of 4

§ 218.82 Permissible methods of taking.

(1) Harassment (Level A and Level B) for all Training and Testing Activities:
(i) Mysticetes:
(A) Blue whale (Balaenoptera musculus) – 817
(C) Fin whale (Balaenoptera physalus) – 25,239
(D) North Atlantic right whale (Eubalaena glacialis) – 955

(E) Humpback whale (Megaptera novaeangliae) – 9,196
(G) Sei whale (Balaenoptera borealis) – 54,766
(ii) Odontocetes:
(V) Sperm whale (Physeter macrocephalus) – 82,282
(iii) Pinnipeds:
(E) Ringed seal (Pusa hispida) – 1,795

(2) Mortality (or lesser Level A injury) for all Training and Testing Activities:
(iii) No more than 11 large whale mortalities from vessel strike.

§ 218.84 Mitigation.

(a) When conducting training and testing activities, as identified in § 218.80, the mitigation measures contained in the LOA issued under §§ 216.106 and 218.87 must be implemented. These mitigation measures include, but are not limited to:

(1) Lookouts – The following are protective measures concerning the use of lookouts.

(i) Lookouts positioned on ships will be dedicated solely to diligent observation of the air and surface of the water. Their observation objectives will include, but are not limited to, detecting the presence of biological resources and recreational or fishing boats, observing mitigation zones, and monitoring for vessel and personnel safety concerns.

(ii) Lookouts positioned in aircraft or on small boats will, to the maximum extent practicable and consistent with aircraft and boat safety and training and testing requirements, comply with the observation objectives described above in § 218.84 (a)(1)(i).

(iii) Lookout measures for non-impulsive sound:

(A) With the exception of ships less than 65 ft (20 m) in length and ships that are minimally manned, ships using low-frequency or hull-mounted mid-frequency active sonar sources associated with anti-submarine warfare and mine warfare activities at sea will have two Lookouts at the forward position of the ship. For the purposes of this rule, low-frequency active sonar does not include surveillance towed array sensor system low-frequency active sonar.

(B) While using low-frequency or hull-mounted mid-frequency active sonar sources associated with anti-submarine warfare and mine warfare activities at sea, vessels less than 65 ft (20 m) in length and ships that are minimally manned will have one Lookout at the forward position of the vessel due to space and manning restrictions.

(C) Ships conducting active sonar activities while moored or at anchor (including pierside testing or maintenance) will maintain one Lookout.

(D) Surface ships or aircraft conducting high-frequency or non-hull-mounted mid-frequency active sonar activities associated with anti-submarine warfare and mine warfare activities at sea will have one Lookout.

(E) Surface ships or aircraft conducting high-frequency active sonar activities associated with anti-submarine warfare and mine warfare activities at sea will have one Lookout.

(iv) Lookout measures for explosives and impulsive sound:

(A) Aircraft conducting activities with IEER sonobuoys and explosive sonobuoys with 0.6 to 2.5 lbs net explosive weight will have one Lookout.

(B) Surface vessels conducting anti-swimmer grenade activities will have one Lookout.

(C) During general mine countermeasure and neutralization activities using up to a 500-lb net explosive weight detonation (bin E10 and below), vessels greater than 200 ft will have two Lookouts, while vessels less than 200 ft or aircraft will have one Lookout.

(D) General mine countermeasure and neutralization activities using a 501 to 650-lb net explosive weight detonation (bin E11), will have two Lookouts. One Lookout will be positioned in an aircraft and one in a support vessel.

(E) Mine neutralization activities involving diver-placed charges using up to 100-lb net explosive weight detonation (E8) conducted with a positive control device will have a total of two Lookouts. One Lookout will be positioned in each of the two support vessels, or one in a support vessel and one in a helicopter. All divers placing the charges on mines will support the Lookouts while performing their regular duties. The divers placing the charges on mines will report all marine mammal sightings to their dive support vessel or Range Safety Officer.

(F) When mine neutralization activities using diver-placed charges with up to a 20-lb net explosive weight detonation (bin E6) are conducted with a time-delay firing device, four Lookouts will be used. Two Lookouts will be positioned in each of two small rigid hull inflatable boats. In addition, when aircraft are used, the pilot or member of the aircrew will serve as an additional Lookout. The divers placing the charges on mines will report all marine mammal sightings to their dive support vessel or Range Safety Officer.

(G) Surface vessels conducting line charge testing will have one Lookout

(H) Surface vessels or aircraft conducting small- and medium-caliber gunnery exercises against a surface target will have one Lookout.

(I) Surface vessels conducting large-caliber gunnery exercises against a surface target will have one Lookout.

(J) Aircraft conducting missile exercises (including rockets) against surface targets will have one Lookout.

(K) Aircraft conducting bombing exercises will have one Lookout.

(L) During explosive torpedo testing, one Lookout will be used and positioned in an aircraft.

(M) During sinking exercises, two Lookouts will be used. One Lookout will be positioned in an aircraft and one on a surface vessel.

(N) Prior to commencing, during, and after completion of ship shock trials using up to 10,000 lb. HBX charges, the Navy will have at least 10 Lookouts or trained marine species observers (or a combination thereof) positioned either in an aircraft or on multiple vessels (i.e., a Marine Animal Response Team boat and the test ship). If aircraft are used, there will be Lookouts or trained marine species observers positioned in an aircraft and positioned on multiple vessels. If vessels are the only platform, a sufficient number of additional Lookouts or trained marine species observers will be used to provide visual observation of the mitigation zone comparable to that achieved by aerial surveys."

(O) Prior to commencing, during, and after completion of ship shock trials using up to 40,000 lb. HBX charges, the Navy will have at least 10 Lookouts or trained marine species observers (or a combination thereof) positioned in an aircraft and on multiple vessels (i.e., a Marine Animal Response Team boat and the test ship).

(P) Each surface vessel supporting at-sea explosive testing will have at least one lookout.

(Q) Surface vessels conducting explosive and non-explosive large-caliber gunnery exercises will have one lookout. This may be the same lookout used during large-caliber gunnery exercises with a surface target as described above in § 218.84 (a)(1)(iv)(I) and below in § 218.84 (a)(1)(v)(C).

(v) Lookout measures for physical strike and disturbance:

(A) While underway, surface ships will have at least one lookout.

(B) During activities using towed in-water devices that are towed from a manned platform, one lookout will be used.

(C) Activities involving non-explosive practice munitions (e.g., small-, medium-, and large-caliber gunnery exercises) using a surface target will have one lookout.

(D) During activities involving non-explosive bombing exercises, one lookout will be used.

(E) During activities involving non-explosive missile exercises (including rockets) using a surface target, one lookout will be used.

(2) Mitigation Zones – The following are protective measures concerning the implementation of mitigation zones.

(i) Mitigation zones will be measured as the radius from a source and represent a distance to be monitored.

(ii) Visual detections of marine mammals within a mitigation zone will be communicated immediately to a watch station for information dissemination and appropriate action.

(iii) Mitigation zones for non-impulsive sound:

(A) When marine mammals are visually detected, the Navy shall ensure that low-frequency and hull-mounted mid-frequency active sonar transmission levels are limited to at least 6 dB below normal operating levels, for sources that can be powered down, if any detected marine mammals are within 1,000 yd (914 m) of the sonar dome (the bow).

(B) The Navy shall ensure that low-frequency and hull-mounted mid-frequency active sonar transmissions are limited to at least 10 dB below the equipment's normal operating levels, for sources that can be powered down, if any detected marine mammals are within 500 yd (457 m) of the sonar dome.

(C) The Navy shall ensure that low-frequency and hull-mounted mid-frequency active sonar transmissions are ceased, for sources that can be turned off during the activity, if any visually detected marine mammals are within 200 yd (183 m) of the sonar dome. Transmissions will not resume until one of the following conditions is met: the animal is observed exiting the mitigation zone, the animal is thought to have exited the mitigation zone based on a determination of its course and speed and the relative motion between the animal and the source, the mitigation zone has been clear from any additional sightings for a period of 30 min., the ship has transited more than 2,000 yd (1.8 km) beyond the location of the last sighting, or the ship concludes that dolphins are deliberately closing in on the ship to ride the ship's bow wave (and there are no other marine mammal sightings within the mitigation zone). Active transmission may resume when dolphins are bow riding because they are out of the main transmission axis of the active sonar while in the shallow-wave area of the bow.

(D) The Navy shall ensure that low-frequency and hull-mounted mid-frequency active sonar transmissions are ceased, for sources that cannot be powered down during the activity, if any visually detected marine mammals are within 200 yd (183 m) of the source. Transmissions will not resume until one of the following conditions is met: the animal is observed exiting the mitigation zone, the animal is thought to have exited the mitigation zone based on a determination of its course and speed and the relative motion between the animal and the source, the mitigation zone has been clear from any additional sightings for a period of 30 min., the ship has transited more than 400 yd (366 m) beyond the location of the last sighting.

(E) When marine mammals are visually detected, the Navy shall ensure that high-frequency and non-hull-mounted mid-frequency active sonar transmission levels are ceased if any visually detected marine mammals are within 200 yd (183 m) of the source. Transmissions will not resume until one of the following conditions is met: the animal is observed exiting the mitigation zone, the animal is thought to have exited the mitigation zone based on a determination of its course and speed and the relative motion between the animal and the source, the mitigation zone has been clear from any additional sightings for a period of 10 min. for an aircraft-deployed source, the mitigation zone has been clear from any additional sightings for a period of 30 min. for a vessel-deployed source, the vessel or aircraft has repositioned itself more than 400 yd. (366 m) away from the location of the last sighting, or the vessel concludes that dolphins are deliberately closing in to ride the vessel's bow wave (and there are no other marine mammal sightings within the mitigation zone).

(iv) Mitigation zones for explosive and impulsive sound:

(A) A mitigation zone with a radius of 600 yd (549 m) shall be established for IEER sonobuoys (bin E4).

(B) A mitigation zone with a radius of 350 yd (320 m) shall be established for explosive sonobuoys using 0.6 to 2.5 lb net explosive weight (bin E3).

(C) A mitigation zone with a radius of 200 yd (183 m) shall be established for anti-swimmer grenades (up to bin E2).

(D) A mitigation zone ranging from 600 yd (549 m) to 2,100 yd (1.9 km), dependent on charge size, shall be established for general mine countermeasure and neutralization activities using positive control firing devices. Mitigation zone distances are specified for charge size in Table 11-2 of the Navy's application.

(E) A mitigation zone ranging from 350 yd (320 m) to 850 yd (777 m), dependent on charge size, shall be established for mine countermeasure and neutralization activities using diver placed positive control firing devices. Mitigation zone distances are specified for charge size in Table 11-2 of the Navy's application.

(F) A mitigation zone with a radius of 1,000 yd (914 m) shall be established for mine neutralization diver placed mines using time-delay firing devices (up to bin E6).

(G) A mitigation zone with a radius of 900 yd (823 m) shall be established for ordnance testing (line charge testing) (bin E4).

(H) A mitigation zone with a radius of 200 yd (183 m) shall be established for small- and medium-caliber gunnery exercises with a surface target (up to bin E2).

(I) A mitigation zone with a radius of 600 yd (549 m) shall be established for large-caliber gunnery exercises with a surface target (bin E5).

(J) A mitigation zone with a radius of 900 yd (823 m) shall be established for missile exercises (including rockets) with up to 250 lb net explosive weight and a surface target (up to bin E9).

(K) A mitigation zone with a radius of 2,000 yd (1.8 km) shall be established for missile exercises with 251 to 500 lb net explosive weight and a surface target (E10)

(L) A mitigation zone with a radius of 2,500 yd (2.3 km) shall be established for bombing exercises (up to bin E12).

(M) A mitigation zone with a radius of 2,100 yd (1.9 km) shall be established for torpedo (explosive) testing (up to bin E11).

(N) A mitigation zone with a radius of 2.5 nautical miles shall be established for sinking exercises (up to bin E12).

(O) A mitigation zone with a radius of 1,600 yd (1.4 km) shall be established for at-sea explosive testing (up to bin E5).

(P) A mitigation zone with a radius of 3.5 nautical miles shall be established for a shock trial.
(Q) A mitigation zone with a radius of 70 yd (64 m), within 30 degrees on either side of the gun target line on the firing side of the ship, shall be established for all explosive and non-explosive large-caliber gunnery exercises.

(v) Mitigation zones for vessels and in-water devices:

(A) A mitigation zone of 500 yd (457 m) for observed whales and 200 yd (183 m) for all other marine mammals (except bow riding dolphins) shall be established for all vessel movement, providing it is safe to do so.
(B) A mitigation zone of 250 yd (229 m) for any observed marine mammal shall be established for all towed in-water devices that are towed from a manned platform, providing it is safe to do so.

(vi) Mitigation zones for non-explosive practice munitions:

(A) A mitigation zone of 200 yd (183 m) shall be established for small, medium, and large caliber gunnery exercises using a surface target.
(B) A mitigation zone of 1,000 yd (914 m) shall be established for bombing exercises.
(C) A mitigation zone of 900 yd (823 m) shall be established for missile exercises (including rockets) using a surface target.

(3) Protective Measures Specific to North Atlantic Right Whales

(i) North Atlantic Right Whale Calving Habitat off the Southeast United States.

(A) The Southeast Right Whale Mitigation Area is defined by a 5 nm (9.3 km) buffer around the coastal waters between 31-15 N. lat. and 30-15 N. lat. extending from the coast out 15 nm (27.8 km), and the coastal waters between 30-15 N. lat. to 28-00 N. lat. from the coast out to 5 nm (9.3 km).
(B) Between November 15 and April 15, the following activities are prohibited within the Southeast Right Whale Mitigation Area:

(1) Low-frequency and hull-mounted mid-frequency active sonar (except as noted below in § 218.84 (a)(3)(i)(C).
(2) High-frequency and non-hull mounted mid-frequency active sonar (except helicopter dipping)
(3) Missile activities (explosive and non-explosive)
(4) Bombing exercises (explosive and non-explosive)
(5) Underwater detonations
(6) Improved extended echo ranging sonobuoy exercises
(7) Torpedo exercises (explosive)
(8) Small-, medium-, and large-caliber gunnery exercises

(C) Between November 15 and April 15, use of the following systems is to be minimized to the maximum extent practicable within the Southeast Right Whale Mitigation Area:

(1) Helicopter dipping using active sonar
(2) Low-frequency and hull-mounted mid-frequency active sonar used for navigation training

(3) Low-frequency and hull-mounted mid-frequency active sonar used for object detection exercises

(D) Prior to transiting or training or testing in the Southeast Right Whale Mitigation Area, ships shall contact Fleet Area Control and Surveillance Facility, Jacksonville, to obtain the latest whale sightings and other information needed to make informed decisions regarding safe speed and path of intended movement. Submarines shall contact Commander, Submarine Force United States Atlantic Fleet for similar information.

(E) The following specific mitigation measures apply to activities occurring within the Southeast Right Whale Mitigation Area:

(1) When transiting within the Southeast Right Whale Mitigation Area, vessels shall exercise extreme caution and proceed at a slow safe speed. The speed shall be the slowest safe speed that is consistent with mission, training, and operations.

(2) Speed reductions (adjustments) are required when a North Atlantic right whale is sighted by a vessel, when the vessel is within 9 km (5 nm) of a sighting reported within the past 12 hours, or when operating at night or during periods of poor visibility.

(3) Vessels shall avoid head-on approaches to North Atlantic right whales(s) and shall 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 a change of course would create an imminent and serious threat to a person, vessel, or aircraft, and to the extent vessels are restricted in their ability to maneuver.

(4) Vessels shall minimize to the extent practicable north-south transits through the Southeast Right Whale Mitigation Area. If transit in a north-south direction is required during training or testing activities, the Navy shall implement the measures described above.

(5) Ship, surfaced subs, and aircraft shall report any North Atlantic right whale sightings to Fleet Area Control and Surveillance Facility, Jacksonville, by the most convenient and fastest means. The sighting report shall include the time, latitude/longitude, direction of movement and number and description of whale (i.e., adult/calf)

(ii) North Atlantic Right Whale Foraging Habitat off the Northeast United States

(A) The Northeast Right Whale Mitigation Area consists of two areas: the Great South Channel and Cape Cod Bay. The Great South Channel is defined by the following coordinates: 41-40 N. Lat., 69-45 W. Long.; 41-00 N. Lat., 69-05 W. Long.; 41-38 N. Lat., 68-13 W. Long.; and 42-10 N. Lat., 68-31 W. Long. Cape Cod Bay is defined by the following coordinates: 42-04.8 N. Lat., 70-10 W. Long.; 42-10 N. Lat., 70-15 W. Long.; 42-12 N. Lat., 70-30 W. Long.; 41-46.8 N. Lat., 70-30 W. Long.; and on the south and east by the interior shoreline of Cape Cod.

(B) Year-round, the following activities are prohibited within the Northeast Right Whale Mitigation Area:

(1) Improved extended echo ranging sonobuoy exercises in or within 5.6 km (3 nm) of the mitigation area.

(2) Bombing exercises (explosive and non-explosive)

(3) Underwater detonations

(4) Torpedo exercises (explosive)

(C) Year-round, use of the following systems is to be minimized to the maximum extent practicable within the Northeast Right Whale Mitigation Area:

(1) Low-frequency and hull-mounted mid-frequency active sonar

(2) High-frequency and non-hull mounted mid-frequency active sonar, including helicopter dipping

(D) Prior to transiting or training in the Northeast Right Whale Mitigation Area, ships and submarines shall contact the Northeast Right Whale Sighting Advisory System to obtain the latest whale sightings and other information needed to make informed decisions regarding safe speed and path of intended movement.

(E) The following specific mitigation measures apply to activities occurring within the Northeast Right Whale Mitigation Area:

(1) When transiting within the Northeast Right Whale Mitigation Area, vessels shall exercise extreme caution and proceed at a slow safe speed. The speed shall be the slowest safe speed that is consistent with mission, training, and operations.

(2) Speed reductions (adjustments) are required when a North Atlantic right whale is sighted by a vessel, when the vessel is within 9 km (5 nm) of a sighting reported within the past week, or when operating at night or during periods of poor visibility.

(3) When conducting TORPEXs, the following additional speed restrictions shall be required: during transit, surface vessels and submarines shall maintain a speed of no more than 19 km/hour (10 knots); during torpedo firing exercises, vessel speeds should, where feasible, not exceed 10 knots; when a submarine is used as a target, vessel speeds should, where feasible, not exceed 18 knots; when surface vessels are used as targets, vessels may exceed 18 knots for a short period of time (e.g., 10-15 minutes).

(4) Vessels shall avoid head-on approaches to North Atlantic right whales(s) and shall 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 a change of course would create an imminent and serious threat to a person, vessel, or aircraft, and to the extent vessels are restricted in their ability to maneuver.

(5) Non-explosive torpedo testing shall be conducted during daylight hours only in Beaufort sea states of 3 or less to increase the probability of marine mammal detection.

(6) Non-explosive torpedo testing activities shall not commence if concentrations of floating vegetation (Sargassum or kelp patties) are observed in the vicinity.

(7) Non-explosive torpedo testing activities shall cease if a marine mammal is visually detected within the immediate vicinity of the activity. The tests may recommence when any one of the following conditions are met: the animal is observed exiting the immediate vicinity of the activity; the animal is thought to have exited the immediate vicinity based on a determination of its course and speed and the relative motion between the animal and the source; or the immediate vicinity of the activity has been clear from any additional sightings for a period of 30 minutes.

(iii) North Atlantic Right Whale Mid-Atlantic Migration Corridor

(A) The Mid-Atlantic Right Whale Mitigation Area consists of the following areas:

(1) Block Island Sound: the area bounded by 40-51-53.7 N. Lat., 70-36-44.9 W. Long.; and 41-20-14.1 N. Lat., 70-49-44.1 W. Long; 41-4-16.7 N. Lat., 71-51-21 W. Long.; 41-35-56.5 N. Lat., 71-38-26.1 W. Long; then back to first set of coordinates.

(2) New York and New Jersey: within a 37 km (20 nm) radius of the following (as measured seaward from the COLREGS lines) 40-29-42.2 N. Lat., 73-55-57.6 W. Long.

(3) Delaware Bay: within a 37 km (20 nm) radius of the following (as measured seaward from the COLREGS lines) 38-52-27.4 N. Lat., 75-01-32.1 W. Long.

(4) Chesapeake Bay: within a 37 km (20 nm) radius of the following (as measured seaward from the COLREGS lines) 37-00-36.9 N. Lat., 75-57-50.5 W. Long.

(5) Morehead City, North Carolina: within a 37 km (20 nm) radius of the following (as measured seaward from the COLREGS lines) 34-41-32 N. Lat., 76-40-08.3 W. Long.

(6)Wilmington, North Carolina, through South Carolina, and to Brunswick, Georgia: within a continuous area 37 km (20 nm) from shore and west back to shore bounded by 34-10-30 N. Lat., 77-49-12 W. Long.; 33-56-42 N. Lat., 77-31-30 W. Long.; 33-36-30 N. Lat., 77-47-06 W. Long.; 33-28-24 N. Lat., 78-32-30 W. Long.; 32-59-06 N. Lat., 78-50-18 W. Long.; 31-50 N. Lat., 80-33-12 W. Long.; 31-27 N. Lat., 80-51-36 W. Long.

(B) Between November 1 and April 30, when transiting within the Mid-Atlantic Right Whale Mitigation Area, vessels shall exercise extreme caution and proceed at a slow safe speed. The speed shall be the slowest safe speed that is consistent with mission, training, and operations.

(iv) Planning Awareness Areas

(A) The Navy shall avoid planning major training exercises involving the use of active sonar in the specified planning awareness areas (PAAs – see Figure 5.3-1 in the AFTT FEIS/OEIS) where feasible. Should national security require the conduct of more than four major exercises (C2X, JTFEX, or similar scale event) in these areas (meaning all or a portion of the exercise) per year, or more than one within the Gulf of Mexico areas per year, the Navy shall provide NMFS with prior notification and include the information in any associated after-action or monitoring reports.

(4) Stranding Response Plan

(i) The Navy shall abide by the current Stranding Response Plan for Major Navy Training Exercises in the Study Area, to include the following measures:

(A) Shutdown Procedures - When an Uncommon Stranding Event (USE - defined in § 218.71 (b)(1)) occurs during a Major Training Exercise (MTE) in the AFTT Study Area, the Navy shall implement the procedures described below.

(1) The Navy shall implement a shutdown (as defined § 218.81(b)(2)) when advised by a NMFS Office of Protected Resources Headquarters Senior Official designated in the AFTT Study Area Stranding Communication Protocol that a USE involving live animals has been identified and that at least one live animal is located in the water. NMFS and the Navy will maintain a dialogue, as needed, regarding the identification of the USE and the potential need to implement shutdown procedures.

(2) Any shutdown in a given area shall remain in effect in that area until NMFS advises the Navy that the subject(s) of the USE at that area die or are euthanized, or that all live animals involved in the USE at that area have left the area (either of their own volition or herded).

(3) If the Navy finds an injured or dead animal floating at sea during an MTE, the Navy shall notify NMFS immediately or as soon as operational security considerations allow. The Navy shall provide NMFS with species or description of the animal(s), the condition of the animal(s), including carcass condition if the animal(s) is/are dead, location, time of first discovery, observed behavior (if alive), and photo or video (if available). Based on the information provided, NFMS will determine if, and advise the Navy whether a modified shutdown is appropriate on a case-by-case basis.

(4) In the event, following a USE, that qualified individuals are attempting to herd animals back out to the open ocean and animals are not willing to leave, or animals are seen repeatedly heading for the open ocean but turning back to shore, NMFS and the Navy shall coordinate (including an investigation of other potential anthropogenic stressors in the area) to determine if the proximity

of mid-frequency active sonar training activities or explosive detonations, though farther than 14 nautical miles from the distressed animal(s), is likely contributing to the animals' refusal to return to the open water. If so, NMFS and the Navy will further coordinate to determine what measures are necessary to improve the probability that the animals will return to open water and implement those measures as appropriate.

(B) Within 72 hours of NMFS notifying the Navy of the presence of a USE, the Navy shall provide available information to NMFS (per the AFTT Study Area Communication Protocol) regarding the location, number and types of acoustic/explosive sources, direction and speed of units using mid-frequency active sonar, and marine mammal sightings information associated with training activities occurring within 80 nautical miles (148 km) and 72 hours prior to the USE event. Information not initially available regarding the 80-nautical miles (148-km), 72-hour period prior to the event will be provided as soon as it becomes available. The Navy will provide NMFS investigative teams with additional relevant unclassified information as requested, if available.

(ii) [Reserved]

§ 218.85 Requirements for Monitoring and Reporting.

(a) As outlined in the AFTT Study Area Stranding Communication Plan, the Holder of the Authorization must notify NMFS immediately (or as soon as clearance procedures allow) if the specified activity identified in § 218.80 is thought to have resulted in the mortality or injury of any marine mammals, or in any take of marine mammals not identified in § 218.81.

(b) The Holder of the LOA must conduct all monitoring and required reporting under the LOA, including abiding by the AFTT Monitoring Plan.

(c) General Notification of Injured or Dead Marine Mammals - Navy personnel shall ensure that NMFS (regional stranding coordinator) is notified immediately (or as soon as clearance procedures allow) if an injured or dead marine mammal is found during or shortly after, and in the vicinity of a Navy training or testing activity utilizing mid- or high-frequency active sonar or underwater explosive detonations. The Navy shall provide NMFS with species identification or description of the animal(s), the condition of the animal(s) (including carcass condition if the animal is dead), location, time of first discovery, observed behaviors (if alive), and photo or video (if available). The Navy shall consult the Stranding Response Plan to obtain more specific reporting requirements for specific circumstances.

(d) Annual AFTT Monitoring Plan Report - The Navy shall submit an annual report of the AFTT Monitoring Plan on April 1 of each year describing the implementation and results from the previous calendar year. Data collection methods will be standardized across range complexes and study areas to allow for comparison in different geographic locations. Although additional information will be gathered, the protected species observers collecting marine mammal data pursuant to the AFTT Monitoring Plan shall, at a minimum, provide the same marine mammal observation data required in § 218.85. As an alternative, the Navy may submit a multi-Range Complex annual Monitoring Plan report to fulfill this requirement. Such a report would describe progress of knowledge made with respect to monitoring plan study questions across all Navy ranges associated with the ICMP. Similar study questions shall be treated together so that progress on each topic shall be summarized across all Navy ranges. The report need not include analyses and content that do not provide direct assessment of cumulative progress on the monitoring plan study questions.

(e) Vessel Strike – In the event that a Navy vessel strikes a whale, the Navy shall do the following:

(1) Immediately report to NMFS (pursuant to the established Communication Protocol) the:

(i) Species identification if known;

(ii) Location (latitude/longitude) of the animal (or location of the strike if the animal has disappeared);

(iii) Whether the animal is alive or dead (or unknown); and

(iv) The time of the strike.

(2) As soon as feasible, the Navy shall report to or provide to NMFS, the:

(i) Size, length, and description (critical if species is not known) of animal;

(ii) An estimate of the injury status (e.g., dead, injured but alive, injured and moving, blood or tissue observed in the water, status unknown, disappeared, etc.);

(iii) Description of the behavior of the whale during event, immediately after the strike, and following the strike (until the report is made or the animal is no long sighted);

(iv) Vessel class/type and operation status;

(v) Vessel length

(vi) Vessel speed and heading; and

(vii) To the best extent possible, obtain

(3) Within 2 weeks of the strike, provide NMFS:

(i) A detailed description of the specific actions of the vessel in the 30-minute timeframe immediately preceding the strike, during the event, and immediately after the strike (e.g., the speed and changes in speed, the direction and changes in the direction, other maneuvers, sonar use, etc., if not classified); and

(ii) A narrative description of marine mammal sightings during the event and immediately after, and any information as to sightings prior to the strike, if available; and

(iii) Use established Navy shipboard procedures to make a camera available to attempt to capture photographs following a ship strike.

(f) Annual AFTT Exercise and Testing Report - The Navy shall submit “quick-look” reports detailing the status of authorized sound sources within 21 days after the end of the annual authorization cycle. The Navy shall submit detailed reports 3 months after the anniversary of the date of issuance of the LOA. The annual reports shall contain information on Major Training Exercises (MTE), Sinking Exercise (SINKEX) events, and a summary of sound sources used, as described below. The analysis in the reports will be based on the accumulation of data from the current year’s report and data collected from previous reports. These reports shall contain information identified in subsections § 218.85(e)(1through 5).

(1) Major Training Exercises/SINKEX -

(i) This section shall contain the reporting requirements for Coordinated and Strike Group exercises and SINKEX. Coordinated and Strike Group Major Training Exercises:

(A) Sustainment Exercise (SUSTAINEX)

(B) Integrated ASW Course (IAC)

(C) Joint Task Force Exercises (JTFEX)

(D) Composite Training Unit Exercises (COMPTUEX)

(ii) Exercise information for each MTE:

(A) Exercise designator

(B) Date that exercise began and ended

(C) Location (operating area)

(D) Number of items or hours (per the LOA) of each sound source bin (impulsive and non-impulsive) used in the exercise

(E) Number and types of vessels, aircraft, etc., participating in exercise

(F) Individual marine mammal sighting info for each sighting for each MTE

1. Date/time/location of sighting
2. Species (if not possible, indication of whale/dolphin/pinniped)
3. Number of individuals
4. Initial detection sensor
5. Indication of specific type of platform the observation was made from (including, for example, what type of surface vessel or testing platform)
6. Length of time observers maintained visual contact with marine mammal(s)
7. Sea state
8. Visibility
9. Sound source in use at the time of sighting
10. Indication of whether animal is <200 yd, 200-500 yd, 500-1,000 yd, 1,000-2,000 yd, or >2,000 yd from sound source
11. Mitigation implementation – whether operation of sonar sensor was delayed, or sonar was powered or shut down,

and how long the delay was; or whether navigation was changed or delayed

12. If source in use is a hull-mounted sonar, relative bearing of animal from ship and estimation of animal's motion relative to ship (opening, closing, parallel)
13. Observed behavior – watchstanders shall report, in plain language and without trying to categorize in any way, the observed behavior of the animal(s) (such as closing to bow ride, paralleling course/speed, floating on surface and not swimming, etc.), and if any calves present

(G) An evaluation (based on data gathered during all of the MTEs) of the effectiveness of mitigation measures designed to minimize the received level to which marine mammals may be exposed. This evaluation shall identify the specific observations that support any conclusions the Navy reaches about the effectiveness of the mitigation.

(iii) Exercise information for each SINKEX:

(A) List of the vessels and aircraft involved in the SINKEX

(B) Location (operating area)

(C) Chronological list of events with times, including time of sunrise and sunset, start and stop time of all marine species surveys that occur before, during, and after the SINKEX, and ordnance used

(D) Visibility and/or weather conditions, wind speed, cloud cover, etc. throughout exercise if it changes

(E) Aircraft used in the surveys, flight altitude, and flight speed and the area covered by each of the surveys, given in coordinates, map, or square miles

(F) Passive acoustic monitoring details (number of sonobuoys, detections of biologic activity, etc.)

(G) Individual marine mammal sighting info for each sighting that required mitigation to be implemented

1. Date/time/location of sighting
2. Species (if not possible, indication of whale/dolphin/pinniped)
3. Number of individuals
4. Initial detection sensor
5. Indication of specific type of platform the observation was made from (including, for example what type of surface vessel or platform)
6. Length of time observers maintained visual contact with marine mammal(s)
7. Sea state
8. Visibility

9. Indication of whether animal is <200 yd, 200-500 yd, 500-1,000 yd, 1,000-2,000 yd, or >2,000 yd from the target
10. Mitigation implementation – whether the SINKEX was stopped or delayed and length of delay
11. Observed behavior – watchstanders shall report, in plain language and without trying to categorize in any way, the observed behavior of the animals (such as animal closing to bow ride, paralleling course/speed, floating on surface and not swimming, etc.), and if any calves present

(H) List of the ordnance used throughout the SINKEX and net explosive weight (NEW) of each weapon and the combined ordnance NEW

(2) Summary of Sources Used

(i) This section shall include the following information summarized from the authorized sound sources used in all training and testing events:

(A) Total annual hours or quantity (per the LOA) of each bin of sonar or other non-impulsive source

(B) Total annual expended/detonated rounds (missiles, bombs, etc.) for each explosive bin

(C) Improved Extended Echo-Ranging System (IEER)/sonobuoy summary, including:

1. Total expended/detonated rounds (buoys)
2. Total number of self-scuttled IEER rounds

(3) Sonar Exercise Notification – The Navy shall submit to NMFS (specific contact information to be provided in LOA) either an electronic (preferably) or verbal report within fifteen calendar days after the completion of any major exercise indicating:

(i) Location of the exercise.

(ii) Beginning and end dates of the exercise.

(iii) Type of exercise.

(4) Geographic Information Presentation – The reports shall present an annual (and seasonal, where practical) depiction of training exercises and testing bin usage geographically across the Study Area.

(5) 5-yr Close-out Exercise and Testing Report – This report will be included as part of the 2019 annual exercise or testing report. This report will provide the annual totals for each sound source bin with a comparison to the annual allowance and the 5-year total for each sound source bin with a comparison to the 5-year allowance. Additionally, if there were any changes to the sound source allowance, this report will include an discussion of why the change was made and include the analysis to support how the change did or did not result in a change in the FEIS and final rule determinations. The report will be submitted April 1 following the expiration of the rule. NMFS will submit comments on the draft close-out report, if any, within 3 months of receipt. The report will be considered final after the Navy has addressed NMFS' comments, or 3 months after the submittal of the draft if NMFS does not provide comments.

(g) Ship Shock Trial Report – The reporting requirements will be developed in conjunction with the individual test-specific mitigation plan for each ship shock trial. This will allow both the Navy and NMFS to take into account specific information regarding location, assets, species, and seasonality.

2.4.2 Proposed MMPA Letters of Authorization for U.S. Navy Atlantic Fleet Training and Testing for November 2013 through November 2018

NMFS' Permits Division proposes to issue two separate letters of authorization (LOA) for training and testing respectvely for the five year period (November 2013 through November 2018) in accordance with the proposed final rule. The substantive requirements of the LOAs are described below. Mitigation requirements are the same as those described in the MMPA rule and therefore are not provided again in the specific LOA sections below.

2.4.2.1 *Letter of Authorization (LOA), Atlantic Fleet Training Activities*

The authorization would be valid for the period of 14 November 2013 through 13 November 2018 and is valid only for the unintentional taking of the species of marine mammals and methods of take identified in 50 CFR § 218.82(b) and Condition (5) of this Authorization incidental to the training activities specified in 50 CFR § 218.80(c) and Condition (4)(a) of this Authorization and occurring within the AFTT Study Area.

2.4.2.1.1 Training Activity Levels

The LOA describes the use of active acoustic sources as follows for annual and non-annual training (non-annual amounts in parentheses):

(i) MF1 – up to 9,844 hours per year
(ii) MF1K – up to 163 hours per year
(iii) MF2 – up to 3,150 hours per year
(iv) MF2K – up to 61 hours per year
(v) MF3 – up to 2,058 hours per year
(vi) MF4 – up to 927 hours per year
(vii) MF5 – up to 14,556 sonobuoys per year
(viii) MF11 – up to 800 hours per year
(ix) MF12 – up to 687 hours per year
(x) HF1 – up to 1,676 hours per year
(xi) HF4 – up to 8,464 hours per year (up to 192 hours)
(xii) ASW1 – up to 128 hours per year
(xiii) ASW2 – up to 2,620 hours per year
(xiv) ASW3 – up to 13,586 hours per year
(xv) ASW4 – up to 1,365 hours per year
(xvi) TORP1 – up to 54 torpedoes per year
(xvii) TORP2 – up to 80 torpedoes per year

The LOA describes the use of the following explosive sources during annual and non-annual training (non-annual amounts in parentheses):

(i) E1 – up to 124,552 detonations per year
(ii) E2 – up to 856 detonations per year (up to 2)
(iii) E3 – up to 3,132 detonations per year
(iv) E4 – up to 2,190 detonations per year (up to 2)
(v) E5 – up to 14,370 detonations per year
(vi) E6 – up to 500 detonations per year
(vii) E7 – up to 322 detonations per year
(viii) E8 – up to 77 detonations per year
(ix) E9 – up to 2 detonations per year
(x) E10 – up to 8 detonations per year
(xi) E11 – up to 1 detonation per year
(xii) E12 – up to 133 detonations per year

2.4.2.1.2 Incidental Take

The annual incidental take of marine mammals from the sources identified in the LOA above, and § 218.80(c) is limited to the species listed in the LOA. For this consultation, we focused on ESA-listed species only. The LOA provides the method of take and the number of times (estimated take based on the authorized amounts of sound source operation):

2.4.2.1.2.1 Level B Harassment

ESA-listed Mysticetes:

Blue whale (Balaenoptera musculus) – 735 (an average of 147 per year)
Fin whale (Balaenoptera physalus) – 22,450 (an average of 4,490 per year)
North Atlantic right whale (Eubalaena glacialis) – 560 (an average of 112 per year)
Humpback whale (Megaptera novaeangliae) – 8,215 (an average of 1,643 per year)
Sei whale (Balaenoptera borealis) – 50,940 (an average of 10,188 per year)

ESA-listed Odontocetes: No instances

2.4.2.1.2.2 Level A Harassment

ESA-listed Mysticetes:

Fin whale (Balaenoptera physalus) – 5 (1 per year)
Humpback whale (Megaptera novaeangliae) – 5 (1 per year)
Sei whale (Balaenoptera borealis) – 5 (1 per year)

ESA-listed Odontocetes: No Instances
ESA-listed Pinnipeds: No Instances

Mortality (or lesser Level A injury): No more than 10 large whale mortalities (no more than 3 in any given year) from vessel strike.

2.4.2.1.3 Mitigation, Monitoring and Reporting

The LOA requires that the U.S. Navy and any individuals operating under their authority must implement mitigation, monitoring, and reporting required pursuant to 50 CFR §§ 218.84 & 218.85 and implement the Terms and Conditions of the LOA when using sources identified in 50

CFR § 218.80. These mitigation, monitoring and reporting requirements are also described in Section 2.4.1 of this Opinion.

2.4.2.2 ***Letter of Authorization (LOA), Atlantic Fleet Testing Activities***
This Authorization is valid only for the unintentional taking of the species of marine mammals and methods of take identified in 50 CFR § 218.82(b) and Condition (5) of this Authorization incidental to the testing activities specified in 50 CFR § 218.80(c) and Condition (4)(a) of this Authorization and occurring within the AFTT Study Area, (as depicted in Figure 1.1-1 in the Navy's FEIS/OEIS). In addition, the Study Area includes U.S. Navy pierside locations where sonar maintenance and testing occurs.

2.4.2.2.1 Testing Activity Levels
The LOA describes the use of active acoustic sources as follows for annual and non-annual testing (non-annual amounts in parentheses):

(i) LF4 – up to 254 hours per year
(ii) LF5 – up to 370 hours per year (up to 240 hours)
(iii) MF1 – up to 220 hours per year
(iv) MF1K – up to 19 hours per year
(v) MF2 – up to 36 hours per year
(vi) MF3 – up to 434 hours per year
(vii) MF4 – up to 776 hours per year
(viii) MF5 – up to 4,184 sonobuoys per year
(ix) MF6 – up to 303 items per year
(x) MF8 – up to 90 hours per year
(xi) MF9 – up to 13,034 hours per year (up to 480 hours)
(xii) MF10 – up to 1,067 hours per year
(xiii) MF12 – up to 144 hours per year
(xiv) HF1 – up to 1,243 hours per year
(xv) HF3 – up to 384 hours per year
(xvi) HF4 – up to 5,572 hours per year
(xvii) HF5 – up to 1,206 hours per year (up to 240 hours)
(xviii) HF6 – up to 1,974 hours per year (up to 720 hours)
(xix) HF7 – up to 366 hours per year (up to 240 hours)
(xx) ASW1 – up to 96 hours per year
(xxi) ASW2 – up to 2,743 sonobuoys per year
(xxii) ASW2 – up to 274 hours per year
(xxiii)ASW3 – up to 948 hours per year
(xxiv) ASW4 – up to 483 devices per year
(xxv) TORP1 – up to 581 torpedoes per year
(xxvi) TORP2 – up to 521 torpedoes per year
(xxvii) M3 – up to 461 hours per year
(xxviii) SD1 and SD2 – up to 230 hours per year
(xxix) FLS2 and FLS3 – up to 365 hours per year (up to 240 hours)
(xxx) SAS1 – up to 6 hours per year
(xxxi) SAS2 – up to 3,424 hours per year (up to 720 hours)

Additionally, the LOA provides the levels of use for the following explosive sources during annual and non-annual testing (non-annual amounts in parentheses):

(i) E1 – up to 25,501 detonations per year (up to 600)
(ii) E2 – up to 0 detonations per year
(iii) E3 – up to 2,912 detonations per year
(iv) E4 – up to 1,432 detonations per year
(v) E5 – up to 495 detonations per year
(vi) E6 – up to 54 detonations per year
(vii) E7 – up to 0 detonations per year
(viii) E8 – up to 11 detonations per year
(ix) E9 – up to 0detonations per year
(x) E10 – up to 10 detonations per year
(xi) E11 – up to 27 detonation per year
(xii) E12 – up to 0 detonations per year
(xiii) E13 – up to 0 detonations per year
(xiv) E14 – up to 4 detonations per year
(xv) E16 – (up to 12)
(xvi) E17 – (up to 4)

2.4.2.2.2 Incidental Take

The annual incidental take of marine mammals from the sources identified in the LOA above, and § 218.80(c) is limited to the species listed in 5(b though d) in the LOA. For this consultation, we focused on ESA-listed species only. The LOA provides the method of take and the indicated number of times (estimated take based on the authorized amounts of sound source operation):

2.4.2.2.2.1 Level B Harassment

ESA-listed Mysticetes:

Blue whale (Balaenoptera musculus) – 82 (up to 18 per year)
Fin whale (Balaenoptera physalus) – 2,784 (up to 599 per year)
North Atlantic right whale (Eubalaena glacialis) – 395 (up to 87 per year)
Humpback whale (Megaptera novaeangliae) – 976 (up to 200 per year)
Sei whale (Balaenoptera borealis) – 3,821 (up to 796 per year)

ESA-listed Odontocetes: Sperm whale (Physeter macrocephalus) – 8,533 (up to 1,786 per year)
ESA-listed Pinnipeds: Ringed seal (Pusa hispida) – 1,795 (an average of 359 per year)

2.4.2.2.2.2 Level A Harassment

ESA-listed Mysticetes: No instances
ESA-listed Odontocetes:

Sperm whale (Physeter macrocephalus) – 6 (up to 5 per year)

ESA-listed Pinnipeds: No instances

2.4.2.2.2.3 Mortality (or lesser Level A injury)

No more than 1 large whale mortality (no more than 1 in any given year) from vessel strike.

2.4.2.2.3 Mitigation, Monitoring and Reporting

The LOA for testing requires that the U.S. Navy and any individuals operating under their authority must implement mitigation, monitoring, and reporting required pursuant to 50 CFR §§ 218.84 & 218.85 and implement the Terms and Conditions of the LOA when using sources identified in 50 CFR § 218.80. These mitigation, monitoring and reporting requirements are also described in Section 2.4.1 of this Opinion.

2.5 Action Area

The action area encompasses the AFTT Study Area (Figure 1) and the area outside the study area where direct and indirect effects of stressors from training and testing activities could be experienced.

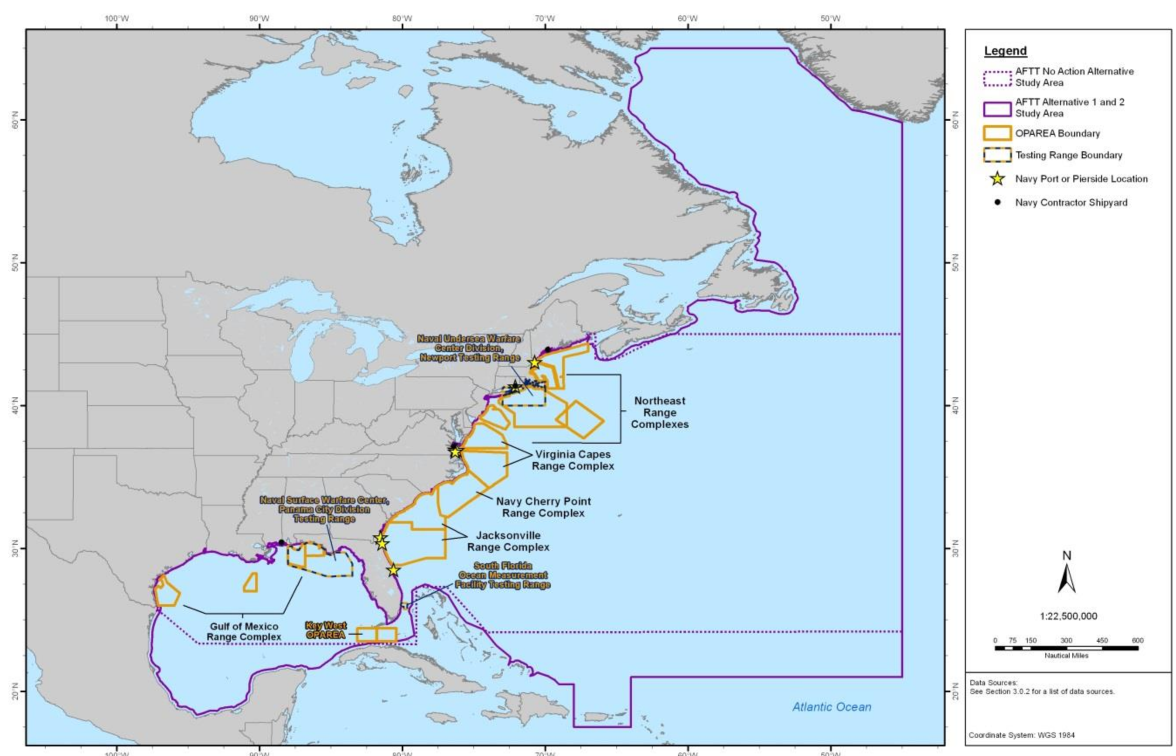

Figure 1. Atlantic Fleet Training and Testing (AFTT) Study Area

2.5.1 **AFTT Study Area**

The Atlantic Fleet Training and Testing (AFTT) FEIS/OEIS Study Area (see Figure 1) is in the western Atlantic Ocean and encompasses the east coast of North America and the Gulf of Mexico. The Study Area starts seaward from the mean high water line east to the 45-degree west longitude line, north to the 65-degree north latitude line, and south to approximately the 20-

degree north latitude line. The Study Area covers approximately 2.6 million square nautical miles (nm^2) of ocean area, and includes designated Navy operating areas (OPAREAs) and special use airspace. Navy pierside locations and port transit channels where sonar maintenance and testing occur, and bays and civilian ports where training occurs (see Sections 2.1.11 of the FEIS/OEIS, Bays, Harbors, and Civilian Ports, and 2.1.12, Pierside Locations) are also included in the Study Area.

The Study Area also includes several Navy testing ranges and range complexes. A range complex is a designated set of specifically bounded geographic areas and encompasses a water component (above and below the surface), airspace, and may encompass a land component where training and testing of military platforms, tactics, munitions, explosives, and electronic warfare systems occur. Range complexes include established OPAREAs and special use airspace, which may be further divided to provide better control of the area and events being conducted for safety reasons.

2.5.2 Operating Area

An ocean area defined by geographic coordinates with defined surface and subsurface areas and associated special use airspace. OPAREAs include the following:

2.5.2.1 *Surface Danger Zones*

A danger zone is a defined water area used for target practice, bombing, rocket firing, or other especially hazardous military activities. Danger zones are established pursuant to statutory authority of the Secretary of the Army and are administered by the United States (U.S.) Army Corps of Engineers. Danger zones may be closed to the public on a full-time or intermittent basis (33 CFR Part 334).

2.5.2.2 *Restricted Areas*

A restricted area is a defined water area for the purpose of prohibiting or limiting public access to the area. Restricted areas generally provide security for government property and also provide protection to the public from the risks of damage or injury arising from the government's use of that area (33 CFR Part 334).

2.5.3 Special Use Airspace

Airspace of defined dimensions where activities must be confined because of their nature or where limitations may be imposed upon aircraft operations that are not part of those activities (Federal Aviation Administration Order 7400.8). Types of special use airspace most commonly found in range complexes include the following:

2.5.3.1 *Restricted Areas*

Airspace where aircraft are subject to restriction due to the existence of unusual, often invisible hazards (e.g., release of ordnance) to aircraft. Some areas are under strict control of the Department of Defense (DoD) and some are shared with non-military agencies.

2.5.3.2 *Military Operations Area*
Airspace with defined vertical and lateral limits established for the purpose of separating or segregating certain military training activities from instrument flight rules traffic and to identify for visual flight rules traffic where these activities are conducted.

2.5.3.3 *Warning Area*
Areas of defined dimensions, extending from 3 nautical miles (nm) outward from the coast of the United States, which serve to warn non-participating aircraft of potential danger.

2.5.3.4 *Air Traffic Control Assigned Airspace*
Airspace of defined vertical/lateral limits, assigned by Air Traffic Control, for the purpose of providing air traffic segregation between the specified activity being conducted within the assigned airspace and other instrument flight rules traffic.

2.5.4 Northeast Range Complexes
The Northeast Range Complexes (see Figure 2) are the Boston Range Complex, Narragansett Bay Range Complex, and Atlantic City Range Complex, which consist of operating areas and associated special use airspace for fleet training and testing activities. The operating areas and special use airspace areas are located in the Boston Operating Area, Narragansett Bay Operating Area, and Atlantic City Operating Area. These complexes occupy waters off the coasts of Maine, New Hampshire, Massachusetts, Rhode Island, Connecticut, New York, and New Jersey.

2.5.5 Naval Undersea Warfare Center Division, Newport Testing Range
The Naval Undersea Warfare Center Division, Newport Testing Range consists of waters within Narragansett Bay, Rhode Island, and nearshore areas of Rhode Island Sound; Block Island Sound, and coastal waters south of Rhode Island. (see Figure 2)

2.5.6 Virginia Capes Range Complex
The Virginia Capes Range Complex consists of an operating area and several associated special use airspaces. The Virginia Capes OPAREA extends southward from the Delaware-Maryland border along the coast of Maryland, Virginia, and North Carolina. (see Figure 2)

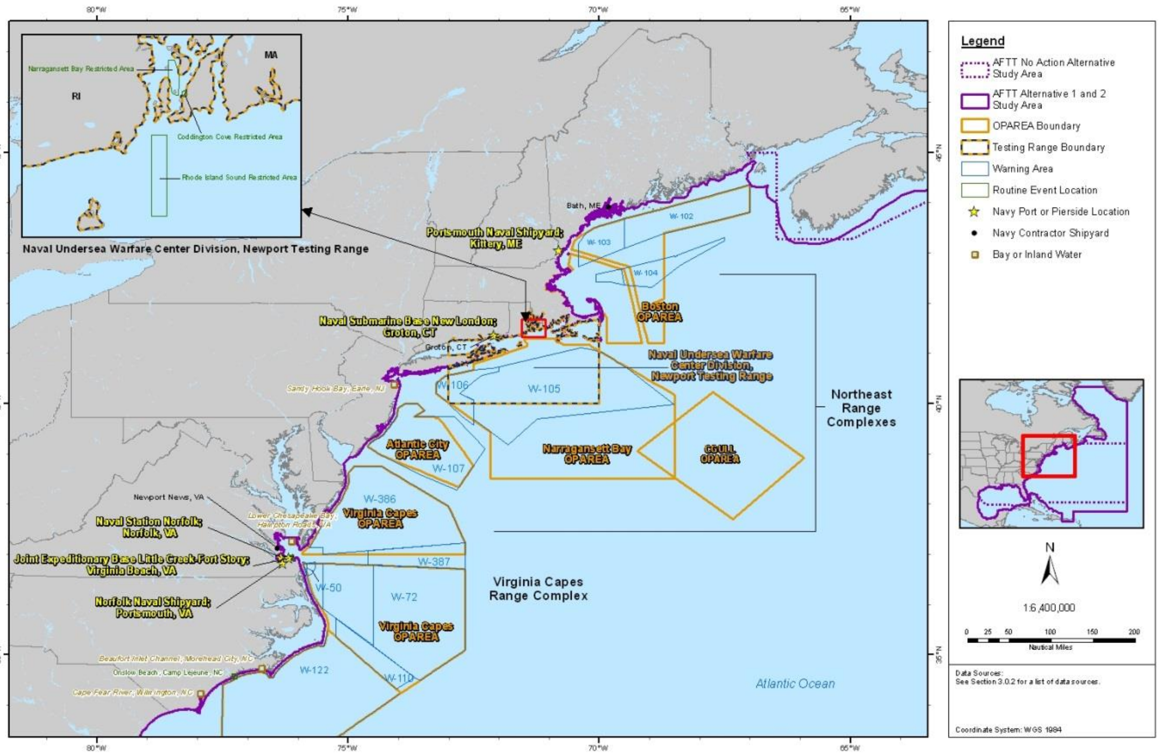

Figure 2. Atlantic Fleet Training and Testing (AFTT) Study Area, Mid-Atlantic U.S.

2.5.7 Navy Cherry Point Range Complex

The Navy Cherry Point Range Complex consists of an OPAREA and associated special use airspace (see Figure 3). The Navy Cherry Point OPAREA extends southeast along the coast of North Carolina.

2.5.8 Jacksonville Range Complex

The Jacksonville Range Complex consists of two OPAREAs and associated special use airspace. The OPAREAs extend southward from the Georgia-South Carolina border and along the coast of Georgia and Florida (see Figure 3).

2.5.9 Naval Surface Warfare Center Carderock Division, South Florida Ocean Measurement Facility Testing Range

The South Florida Ocean Measurement Facility Testing Range is located at two sites just south of Fort Lauderdale, Florida (see Figure 3).

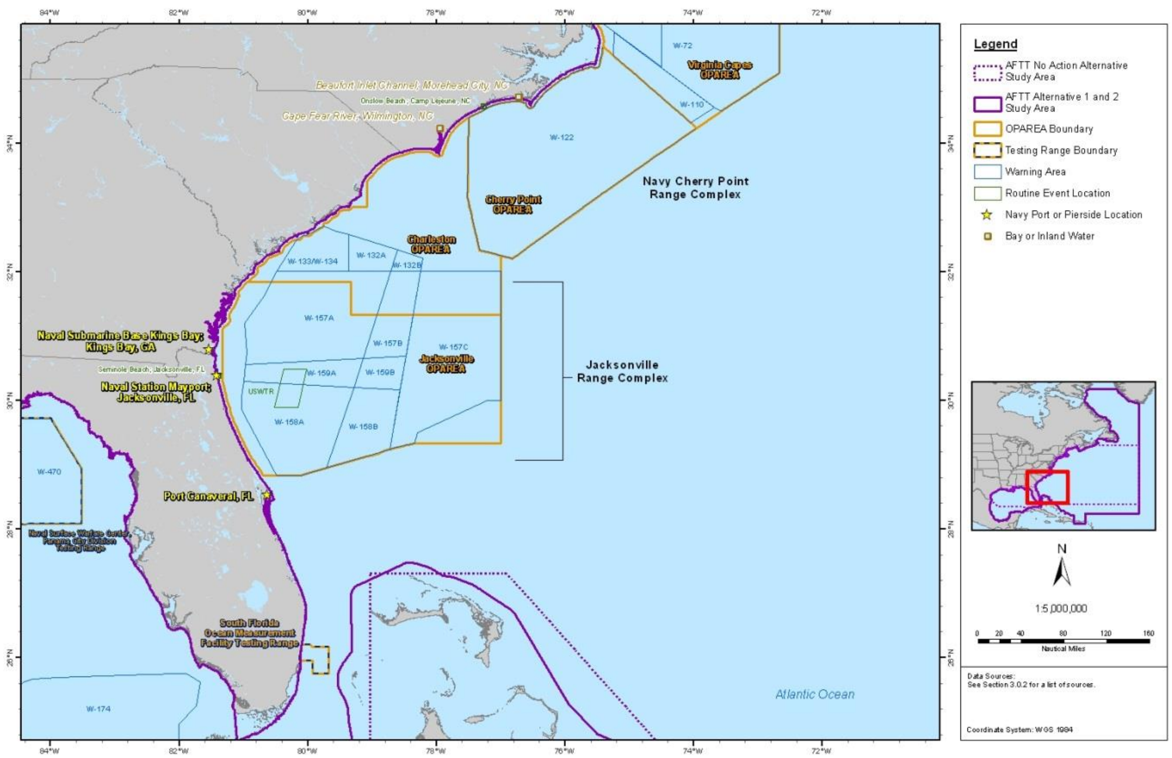

Figure 3. Atlantic Fleet Training and Testing (AFTT) Study Area, Southeastern U.S.

2.5.10 **Key West Range Complex**

The Key West Range Complex consists of an OPAREA and associated extensive special use airspace in proximity to Key West, Florida (see Figure 4).

2.5.11 **Gulf of Mexico Range Complex**

The Gulf of Mexico Range Complex consists of four OPAREAs and associated special use airspace in the Gulf of Mexico. These four OPAREAs are proximal to Panama City, Pensacola, New Orleans, and Corpus Christi (see Figure 4).

2.5.12 **Naval Surface Warfare Center, Panama City Division Testing Range**

The Naval Surface Warfare Center, Panama City Division conducts testing activities in the Pensacola and Panama City OPAREAs, in St. Andrew Bay, and military warning areas W-151, W-155, and W-470 (see Figure 4).

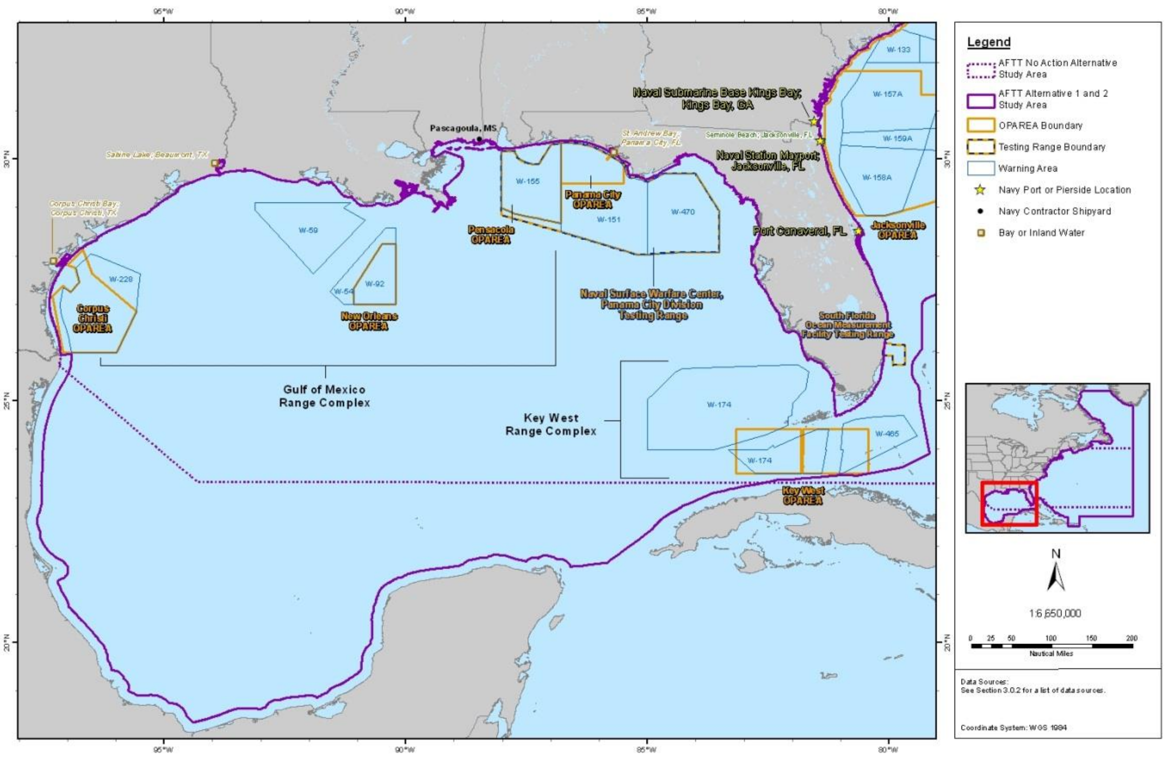

Figure 4. Atlantic Fleet Training and Testing (AFTT) Study Area, Gulf of Mexico, U.S.

2.5.13 **Bays, Harbors and Civilian Ports**

The Study Area includes Narragansett Bay, the lower Chesapeake Bay, and St. Andrew Bay for training and testing activities. Ports included for civilian port defense training events include Earle, New Jersey; Groton, Connecticut; Norfolk, Virginia; Morehead City, North Carolina; Wilmington, North Carolina; Kings Bay, Georgia; Mayport, Florida; Beaumont, Texas; and Corpus Christi, Texas.

2.5.14 **Pierside Locations**

Pierside locations include channels and transit routes in ports and facilities associated with ports and shipyards. These locations in the Study Area are located at the following Navy ports and naval shipyards:

- Portsmouth Naval Shipyard, Kittery, Maine;
- Naval Submarine Base New London, Groton, Connecticut;
- Naval Station Norfolk, Norfolk, Virginia;
- Joint Expeditionary Base Little Creek – Fort Story, Virginia Beach, Virginia;
- Norfolk Naval Shipyard, Portsmouth, Virginia;
- Naval Submarine Base Kings Bay, Kings Bay, Georgia;
- Naval Station Mayport, Jacksonville, Florida; and
- Port Canaveral, Cape Canaveral, Florida.

Navy-contractor shipyards in the following cities are also in the Study Area:

- Bath, Maine;
- Groton, Connecticut;
- Newport News, Virginia; and
- Pascagoula, Mississippi.

3 Approach to the Assessment

Section 7(a)(2) of the ESA requires Federal agencies, in consultation with NMFS, to insure that their actions are not likely to jeopardize the continued existence of endangered or threatened species, or adversely modify or destroy their designated critical habitat. The jeopardy analysis considers both survival and recovery of the species. The adverse modification analysis considers the impacts on the conservation value of designated critical habitat.

"To jeopardize the continued existence of a listed species" means to engage in an action that reasonably would be expected, directly or indirectly, to reduce appreciably the likelihood of both the survival and recovery of a listed species in the wild by reducing the reproduction, numbers, or distribution of that species (50 CFR §402.02).

This biological opinion does not rely on the regulatory definition of "destruction or adverse modification" of critical habitat at 50 C.F.R. 402.02. Instead, we have relied upon the statutory provisions of the ESA to complete the following analysis with respect to critical habitat.[1]

3.1 Overview of NMFS' Assessment Framework

We will use the following approach to determine whether the proposed action is likely to jeopardize listed species or destroy or adversely modify critical habitat:

Identify the rangewide status of the species and critical habitat likely to be adversely affected by the proposed action.

Describe the environmental baseline in the action area. The environmental baseline includes the past and present impacts of Federal, state, or private actions and other human activities *in the action area* (Figure 1). It includes the anticipated impacts of proposed Federal projects that have already undergone formal or early section 7 consultation and the impacts of state or private actions that are contemporaneous with the consultation in process.

[1] Memorandum from William T. Hogarth to Regional Administrators, Office of Protected Resources, NMFS (Application of the "Destruction or Adverse Modification" Standard Under Section 7(a)(2) of the Endangered Species Act) (November 7, 2005).

Analyze the effects of the proposed action on both species and their habitat. In this step, we consider how the proposed action would affect the species' reproduction, numbers, and distribution or, in the case of salmon and steelhead, their viable salmonid population (VSP) parameters. We also evaluate the proposed action's effects on critical habitat features.

Describe any cumulative effects in the action area. Cumulative effects, as defined in our implementing regulations (50 CFR §402.02), are the effects of future state or private activities, not involving Federal activities, that are reasonably certain to occur within the action area. Future Federal actions that are unrelated to the proposed action are not considered because they require separate section 7 consultation.

We integrate and synthesize the above factors to assess the risk that the proposed action poses to species and critical habitat. In this step (*Integration and Synthesis*), we add the effects of the action (Section 6) to the *Environmental Baseline* (Section 5) and the *Cumulative Effects* (Section 6.10) to assess whether the action could reasonably be expected to: (1) reduce appreciably the likelihood of both survival and recovery of the species in the wild by reducing its numbers, reproduction, or distribution; or (2) reduce the conservation value of designated or proposed critical habitat. These assessments are made in full consideration of the *Status of the Species* and critical habitat (Section 4).

Reach jeopardy and adverse modification C*onclusion*. In this step (Section 8) we state our conclusions regarding jeopardy and the destruction or adverse modification of critical habitat are presented in Section 8. These conclusions flow from the logic and rationale presented in Section 7 (*Integration and Synthesis*).

If necessary, define a reasonable and prudent alternative to the proposed action. If, in completing the last step in the analysis, we determine that the action under consultation is likely to jeopardize the continued existence of listed species or destroy or adversely modify designated critical habitat, we must identify a reasonable and prudent alternative (RPA) to the action. The RPA must not be likely to jeopardize the continued existence of listed species nor adversely modify their designated critical habitat and it must meet other regulatory requirements.

3.2 Risk Analysis for Endangered and Threatened Species

Our jeopardy determinations must be based on an action's effects on the continued existence of threatened or endangered species as those "species" have been listed, which can include true biological species, subspecies, or distinct population segments of vertebrate species. Because the continued existence of listed species depends on the fate of the populations that comprise them, the viability (that is, the probability of extinction or probability of persistence) of listed species depends on the viability of the populations that comprise the species. Similarly, the continued existence of populations are determined by the fate of the individuals that comprise them; populations grow or decline as the individuals that comprise the population live, die, grow, mature, migrate, and reproduce (or fail to do so).

Our risk analyses reflect these relationships between listed species and the populations that comprise them, and the individuals that comprise those populations. Our risk analyses begin by identifying the probable risks actions pose to listed individuals that are likely to be exposed to an action's effects. Our analyses then integrate those individuals risks to identify consequences to the populations those individuals represent. Our analyses conclude by determining the consequences of those population-level risks to the species those populations comprise.

We measure risks to listed individuals using the individual's "fitness," which are changes in an individual's growth, survival, annual reproductive success, or lifetime reproductive success. In particular, we examine the scientific and commercial data available to determine if an individual's probable response to an Action's effects on the environment (which we identify in our *response analyses*) are likely to have consequences for the individual's fitness.

When individual, listed plants or animals are expected to experience reductions in fitness, we would expect those reductions to also reduce the abundance, reproduction rates, or growth rates (or increase variance in one or more of these rates) of the populations those individuals represent (Stearns 1992a). Reductions in one or more of these variables (or one of the variables we derive from them) is a *necessary* condition for reductions in a population's viability, which is itself a *necessary* condition for reductions in a species' viability. Therefore, when listed plants or animals exposed to an Action's effects are *not* expected to experience reductions in fitness, we would not expect that Action to have adverse consequences on the viability of the populations those individuals represent or the species those populations comprise (Anderson 2000a; Mills and Beatty 1979; Stearns 1992a). As a result, if we conclude that listed plants or animals are *not* likely to experience reductions in their fitness, we would conclude our assessment because an Action that is not likely to affect the fitness of individuals is not likely to jeopardize the continued existence of listed species.

If, however, we conclude that listed plants or animals are likely to experience reductions in their fitness, our assessment tries to determine if those fitness reductions are likely to be sufficient to reduce the viability of the populations those individuals represent (measured using changes in the populations' abundance, reproduction, spatial structure and connectivity, growth rates, or variance in these measures to make inferences about the population's extinction risks). In this step of our analyses, we use the population's base condition (established in the *Environmental Baseline* and *Status of Listed Resources* sections of this Opinion) as our point of reference. Finally, our assessment tries to determine if changes in population viability are likely to be sufficient to reduce the viability of the species those populations comprise. In this step of our analyses, we use the species' status (established in the *Status of the Species* section of this Opinion) as our point of reference and we use our understanding of the general patterns and processes by which species become extinct to help inform our decision about whether changes in the performance of one or more populations are likely to affect the viability of the species those populations comprise.

3.3 Risk Analysis for Designated Critical Habitat

Our "destruction or adverse modification" determinations must be based on an action's effects on the conservation value of habitat that has been designated as critical to threatened or endangered species[2]. If an area encompassed in a critical habitat designation is likely to be exposed to the *direct or indirect consequences of the proposed action on the natural environment*, we ask if primary or secondary constituent elements included in the designation (if there are any) or physical or biotic phenomena that give the designated area value for the conservation are likely to respond to that exposure.

In this step of our assessment, we identify (a) the spatial distribution of stressors and subsidies produced by an action; (b) the temporal distribution of stressors and subsidies produced by an action; (c) changes in the spatial distribution of the stressors with time; (d) the intensity of stressors in space and time; (e) the spatial distribution of physical and biological features of designated critical habitat; and (f) the temporal distribution of constituent elements of designated critical habitat.

If primary constituent elements of designated critical habitat (or physical, chemical, or biotic phenomena that give the designated area value for the conservation of listed species) are likely to respond given exposure to the *direct or indirect consequences of the proposed action on the natural environment*, we ask if those responses are likely to be sufficient to reduce the quantity, quality, or availability of those constituent elements or physical, chemical, or biotic phenomena.

In this step of our assessment, we must identify or make assumptions about (a) the habitat's probable condition before any exposure as our point of reference (that is part of the impact of the *Environmental Baseline* on the conservation value of the designated critical habitat); (b) the ecology of the habitat at the time of exposure; (c) where the exposure is likely to occur; and (d) when the exposure is likely to occur; (e) the intensity of exposure; (f) the duration of exposure; and (g) the frequency of exposure.

In this step of our assessment, we recognize that the conservation value of critical habitat, like the base condition of individuals and populations, is a dynamic property that changes over time in response to changes in land use patterns, climate (at several spatial scales), ecological processes, changes in the dynamics of biotic components of the habitat, etc. For these reasons, some areas of critical habitat might respond to an exposure when others do not. We also consider how designated critical habitat is likely to respond to any interactions and synergisms between or cumulative effects of pre-existing stressors and proposed stressors.

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[2] We are aware that several courts have ruled that the definition of destruction or adverse modification that appears in the section 7 regulations at 50 CFR §402.02 is invalid and do not rely on that definition for the determinations we make in this Opinion. Instead, as we explain in the text, we use the "conservation value" of critical habitat for our determinations which focuses on the designated area's ability to contribute to the conservation or the species for which the area was designated.

If the quantity, quality, or availability of the primary constituent elements of the area of designated critical habitat (or physical, chemical, or biotic phenomena) are reduced, we ask if those reductions are likely to be sufficient to reduce the conservation value of the designated critical habitat for listed species in the action area. In this step of our assessment, we combine information about the contribution of constituent elements of critical habitat (or of the physical, chemical, or biotic phenomena that give the designated area value for the conservation of listed species, particularly for older critical habitat designations that have no constituent elements) to the conservation value of those areas of critical habitat that occur in the action area, given the physical, chemical, biotic, and ecological processes that produce and maintain those constituent elements in the action area. We use the conservation value of those areas of designated critical habitat that occur in the action area as our point of reference for this comparison. For example, if the critical habitat in the action area has limited current value or potential value for the conservation of listed species that limited value is our point of reference for our assessment.

If the conservation value of designated critical habitat in an action area is reduced, the final step of our analyses asks if those reductions are likely to be sufficient to reduce the conservation value of the entire critical habitat designation. In this step of our assessment, we combine information about the constituent elements of critical habitat (or of the physical, chemical, or biotic phenomena that give the designated area value for the conservation of listed species, particularly for older critical habitat designations that have no constituent elements) that are likely to experience changes in quantity, quality, and availability given exposure to an action with information on the physical, chemical, biotic, and ecological processes that produce and maintain those constituent elements in the action area. We use the conservation value of the entire designated critical habitat as our point of reference for this comparison. For example, if the designated critical habitat has limited current value or potential value for the conservation of listed species that limited value is our point of reference for our assessment.

3.4 Defining "Significance"

In biological opinions, we focus on potential physical, chemical, or biotic stressors that are "significant" in the sense of being distinct from ambient or background. We then ask if

a. exposing individuals to those potential stressors is likely to represent a "significant" negative experience in the life history of individuals that have been exposed; and if

b. exposing individuals to those potential stressors is likely to cause the individuals to experience "significant" physical, chemical, or biotic responses; and if

c. any "significant" physical, chemical, or biotic response are likely to have "significant" consequence for the fitness of the individual animal; and if

d. exposing the physical, chemical, or biotic phenomena that we identified as constituent elements in a critical habitat designation or, in the case of critical habitat designations that do not identify constituent elements, those physical, chemical or biotic phenomena that give designated critical habitat value for the conservation of endangered or threatened species is likely to represent a "significant" change in the quantity, quality, or availability of the physical, chemical, or biotic resource; and if

e. any "significant" change in the quantity, quality, or availability of a physical, chemical, or biotic resource is likely to "significantly" reduce the conservation value of the designated critical habitat.

In all of these cases, the term "significant" means "clinically or biotically significant" rather than statistically significant because the presence or absence of statistical significance do not imply the presence or absence of clinical significance (Achinstein 2001; Royall 2004) (Johnson 1999).

For populations (or sub-populations, demes, etc.), we are concerned about whether the number of individuals that are likely to experience "significant" reductions in fitness and the nature of any fitness reductions are likely to have a "significant" consequence for the viability (= probability of demographic, ecological, or genetic extinction) of the population(s) those individuals represent. Here "significant" also means "clinically or biotically significant" rather than statistically significant.

For "species" (the entity that has been listed as endangered or threatened, not the biological species concept), we are concerned about whether the number of populations that are likely to experience "significant" reductions in viability (= increases in their extinction probabilities) and the nature of any reductions in viability are likely to have "significant" consequence for the viability (= probability of demographic, ecological, or genetic extinction) of the "species" those population comprise. Here, again, "significant" also means "clinically or biotically significant" rather than statistically significant.

For designated critical habitat, we are concerned about whether the area that has been designated is likely to experience "significant" reductions in the quantity, quality, or availability of physical, chemical, or biotic resources that are likely to result in "significant" reductions in the conservation value (usually measured using the concept of "carrying capacity") of the entire are contained in the designation.

3.5 Evidence Available for the Consultation

To conduct these analyses, we considered all lines of evidence available through published and unpublished sources that represent evidence of adverse consequences or the absence of such consequences. Over the past decade, a considerable body of scientific information on anthropogenic sounds and their effect on marine mammals and other marine life has become available. Many investigators have studied the potential responses of marine mammals and other marine organisms to human-generated sounds in marine environments or have integrated and synthesized the results of these studies. Additionally, recent NMFS status reviews for listed species also provide information on the status of the species including their resiliency, population trends and specific threats to recovery that contributes to our *Status of the Species*, *Environmental Baseline*, and Risk Analyses.

To supplement that body of knowledge, we conducted electronic literature searches using the *Web of Science*, and Cambridge Abstract's *Aquatic Sciences and Fisheries Abstracts* (ASFA) database services. Our searches specifically focus on the *ArticleFirst*, *BasicBiosis*, *Dissertation Abstracts*, *Conference Papers Index*, *Oceanic Abstracts*, *Water Resources Abstracts*, *Proceedings* and *ECO* databases, which index the major journals dealing with issues of biology and ecological risk. In addition to these sources, we searched a NMFS Office of Protected Resources electronic library consisting of information from these and many other sources that collectively provide a comprehensive collection of citations and documents on listed species as well as the anthropogenic and natural stressors they experience. To supplement our searches, we examined the literature that was cited in the submittal documents and any articles we collected through our electronic searches. We did not conduct hand searches of published journals for this consultation. We organized the results of these searches using commercial bibliographic software.

To comply with our obligation to use the best scientific and commercial data available, we conducted additional searches throughout the consultation and during drafting of the biological opinion to identify information that has become available since we issued the previous biological opinions on the training and testing conducted by the U.S. Navy's Atlantic Fleet. The U.S. Navy provided NMFS with a draft and final Environmental Impact Statement (EIS)/ Overseas Environmental Impact Statement (OEIS) on training and testing that are proposed in the Action Area. We also evaluated the Navy's annual and comprehensive major training exercise and monitoring reports to assess effectiveness of mitigation and actual take incidental to actual training and testing activity levels where feasible.

NMFS is currently in the process of re-evaluating the acoustic criteria as they apply to all activity types (not just the Navy). Although our current use of acoustic criteria and acoustic thresholds represents the best available science at the time of this action, our continued evaluation of all available science and that science's application in the context of an acoustic threshold could potentially result in changes to the acoustic criteria to the extent they are relevant to Navy activities. However, it is important to note that while changes in acoustic criteria may affect the enumeration of "takes," they do not necessarily significantly change the evaluation of population level effects or the outcome of a jeopardy analysis. Further, while acoustic criteria may also inform mitigation and monitoring activities, the Navy has a robust adaptive management program that actively and regularly addresses new information and allows for modification of mitigation and/or monitoring measures as appropriate. When new information is identified that would potentially change our conclusions on population-level effects or our jeopardy analysis, reinitiation of consultation would be prudent.

Considering the information that was available, this consultation and our biological opinion involved a large amount of uncertainty about the basic hearing capabilities of marine mammals, sea turtles, and fishes; how these taxa use sounds as environmental cues, how they perceive acoustic features of their environment; the importance of sound to the normal behavioral and social ecology of species; the mechanisms by which human-generated sounds affect the behavior and physiology (including the non-auditory physiology) of exposed individuals, and the circumstances that are likely to produce outcomes that have adverse consequences for individuals and populations of exposed species (see NRC 2000 for further discussion of these unknowns).

3.5.1 The U.S. Navy Acoustic Effects Model (NAEMO)

Since 1997, the U.S. Navy has modeled the potential acoustic effects on marine mammals and sea turtles from specific Navy training and test activities. Various models used "area density" approaches in which acoustic footprints were computed and then multiplied by animal densities to calculate effects. As a result of a review conducted by the Center for Independent Experts, as required by the National Marine Fisheries Service, the Navy refined its process. The new model—the Navy Acoustic Effects Model (NAEMO)—is the standard model now used by the Navy to estimate the potential acoustic effects of proposed Navy training and testing activities on marine mammals and sea turtles.

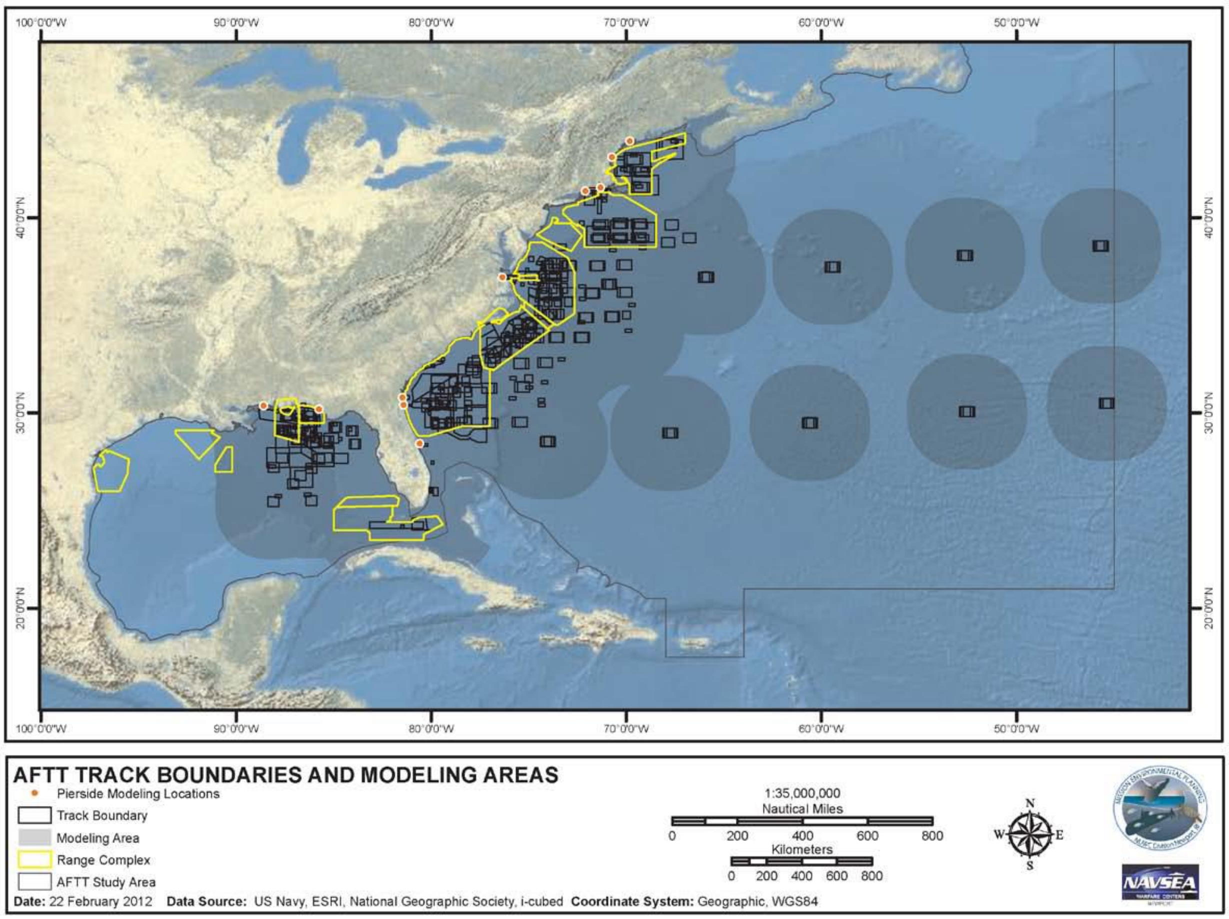

Figure 5. NAEMO. AFTT Track Boundaries and Modeling Areas Within the Study Area

NAEMO is comprised of seven modules: Scenario Builder, Environment Builder, Acoustic Builder, Marine Species Distribution Builder, Scenario Simulator, Post Processor, and Report Generator. Scenario Builder is a graphical user interface (GUI)-based tool that defines where an activity would occur, the duration of the activity, a description of the activity, and what platforms would be participating. Once a platform is identified, all the sound sources typically associated with that platform are displayed, thus providing standardization and repeatability when different analysts are entering data. Individual sources can be turned on or off according to the requirements of the scenario. Platforms are either stationary or can be moved through the action area in either a defined track or random straight-line movement.

Environment Builder is a GUI that extracts all of the oceanographic and environmental data required for a scenario simulation. When an area is selected, information on bathymetry, sound speed profiles, wind speeds, and bottom properties are extracted from an array of points across the region, using Oceanographic and Atmospheric Master Library (OAML) databases. Seasonal averages are created for the sound speed profiles and wind speeds from historical average values.

Acoustic Builder is a GUI that generates acoustic propagation data. It reads the Scenario Builder file, allows the user to define analysis points for propagation software, and creates the propagation model inputs. Depending on the source characteristics, the propagation models utilized are Comprehensive Acoustic Simulation System/Gaussian Ray Bundle (CASS/GRAB), Range-Dependent Acoustic Model (RAM), or Reflection and Refraction Multilayered Ocean/Ocean Bottoms with Shear Wave Effects (REFMS).

Marine Species Distribution Builder is a module that allows the user to distribute marine species within the modeling environment in accordance with the bathymetry and relevant descriptive data. Marine species density data, which include seasonal information when available, are obtained from the Navy Marine Species Density Database (NMSDD); the sizes of cells and density of marine species within each cell vary by species and location.

Scenario Simulator executes the simulation and records the sound received by each marine mammal and sea turtle in the area for every time step that sound is emitted; it incorporates the scenario definition, sound propagation data, and marine species distribution data, ultimately providing raw data output for each simulation. Most scenarios are run in small, 4- to 12-hour segments based on representative training and testing activities. Some scenarios are evaluated by platform and single locations, while others are evaluated in multiple locations within a single range complex or testing range. Within each scenario, multiple ship track iterations are run to provide a statistical set of raw data results.

Post Processor provides the computation of estimated effects that exceed defined threshold criteria from each of the raw data files produced by Scenario Simulator which are designed for determining harassment and mortality as defined by the MMPA for military readiness activities. It also affords the option to review the output data through a series of tables and graphs.

Report Generator enables the user to assemble a series of simulation results created by multiple post-processing runs and produce a combined result. Multipliers can be applied to each scenario to compute the effects of conducting them multiple times. Results can also be exported via Microsoft Excel files for further analysis and reporting.

Modeled effects from NAEMO were used to support the U.S. Navy's analyses in the AFTT Environmental Impact Statement/Overseas Environmental Impact Statement, mitigation strategies, and documentation associated with Endangered Species Act Biological Evaluations and Marine Mammal Protection Act permit applications. We have verified methodology and data used in NAEMO for these analyses and thus accept the modeling conclusions on exposure of marine species. We have verified the methodology and data used in NAEMO for these analyses, accept the modeling conclusions on exposure of marine species, and have considered those exposures in our analysis. A full description of NAEMO can be accessed in the NUWC-NPT Technical Report 12,071a, 23 Agust 2013 (updated from 12 March 2012).

Additionally, the Navy has produced a Technical Report to describe the post model quantitative analysis that was applied {Navy, 2013 #155856}.

3.6 Treatment of "Cumulative Impacts" (in the sense of NEPA)

The U.S. Council on Environmental Quality defined "cumulative effects" (which we refer to as "cumulative impacts" to distinguish between NEPA and ESA uses of the same term) 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). The effects analyses of biological opinions considered the "impacts" on listed species and designated critical habitat that result from the incremental impact of an action by identifying natural and anthropogenic stressors that affect endangered and threatened species throughout their range (the *Status of the Species*) and within an Action Area (the *Environmental Baseline*, which articulate the pre-existing *impacts* of activities that occur in an Action Area, including the past, contemporaneous, and future *impacts* of those activities). We assess the effects of a proposed action by adding their direct and indirect effects to the *impacts* of the activities we identify in an *Environmental Baseline* (50 CFR §402.02), in light of the impacts of the status of the listed species and designated critical habitat throughout their range; as a result, the results of our effects analyses are equivalent to those contained in the "cumulative impact" sections of NEPA documents.

We considered potential cumulative impacts as part of our consultation. Specifically, we considered (1) impacts or effects that accumulate in the environment in the form of stressors or reservoirs of stressors and (2) impacts or effects that represent either the response of individuals, populations, or species to that accumulation of stressors in the environment or the accumulated responses of individuals, populations, and species to sequences of exposure to stressors. Further, we considered the potential impacts of these accumulative phenomema on an annual basis, over the duration of the five-year MMPA regulations, and under the assumption that these activities would continue into the reasonably foreseeable future. Given the ongoing nature of the proposed activities, we assume that the type, amount, and extent of training and testing do not exceed maximum levels assessed in the proposed action.

In the sense of Item 1, which captures the normal usage of "cumulative impacts," we concluded that phenomena like sound do not accumulate (sound energy rapidly transforms into other forms of energy), although phenomena like the acreage of habitat destroyed and concentrations of toxic chemicals, sediment, and other pollutants accumulate. We conclude that the probability of a ship strip accumulated , in the sense that the probabilities of collisions associated with multiple transits are higher than the probabilities associated with a single transit. We factored those considerations into our estimation of the probability of a collision associated with multiple transits.

In the sense of Item 2, we considered phenomena that accumulate in individuals and individually contribute or collectively determine the probable fitness of the individuals that comprise a population. These include, the passage of time and its corollary, the passage or loss of time (specifically, the loss of time to reproduce, to forage, and to migrate, etc.); reproductive success; longevity; energy debt, including allostatic loading; body burdens of toxic chemicals; the fitness costs of behavioral decisions (canonical costs); injuries and tissue damage; and overstimulation of sensory organs (which would include noise-induced losses of hearing sensitivity).

At the level of populations, phenomena that "accumulate" include population abundance; the number or percent of individuals in a population with lifetime reproductive success greater than 2.0; the number or percent of individuals in a population with lifetime reproductive success equal to 2.0; the number or percent of individuals in a population with lifetime reproductive success less than 2.0; the number or percent of individuals that emigrate from a population per unit time; the number or percent of individuals that immigrate into a population per unit time; mortality within a particular age or stage over generation time; and the reservoir of juveniles in a population that have a high probability of surviving to the age of reproduction (population momentum or its absence).

At the species level, we accumulate those phenomena that allow us to estimate the extinction risks facing a species. These include increases or decreases in the number of occurrences or populations; the extinction probability of particular occurrences; variance in the rates of population growth or decline; and demographic stochasticity.

Cummulative effects also include effects of future State, tribal, local, or private actions that are reasonably certain to occur in the action area considered in this biological opinion. Future Federal actions that are unrelated to the proposed action are not considered in this section because they require separate consultation pursuant to Section 7 of the ESA.

4 Status of Listed Resources

This section identifies the ESA-listed species that potentially occur within the Action Area that may be affected by U.S. Navy Atlantic Fleet training and testing. It then summarizes the biology and ecology of those species and what is known about their life histories in the Action Area. The species potentially occurring within the action area are listed in Table 28, along with their regulatory status.

4.1 ESA-listed Species and Designated Critical Habitat That May be Affected by the Proposed Action

This section identifies the ESA-listed species that potentially occur within the Action Area that may be affected by U.S. Navy Atlantic Fleet training and testing. It then summarizes the biology and ecology of those species and what is known about their life histories in the Action Area. The species potentially occurring within the action area are listed in Table 28, along with their regulatory status.

Table 28. ESA-listed Species that May be Affected by U.S. Navy Atlantic Fleet Training and Testing Activities

Species	ESA Status	Critical Habitat	Recovery Plan
Marine Mammals – Cetaceans			
Blue Whale (*Balaenoptera musculus*)	E – 35 FR 18319	-- --	07/1998
Fin Whale (*Balaenoptera physalus*)	E – 35 FR 18319	-- --	75 FR 47538
Humpback Whale (*Megaptera novaeangliae*)	E – 35 FR 18319	-- --	55 FR 29646
North Atlantic Right Whale (*Eubalaena glacialis*)	E – 73 FR 12024	59 FR 28805	70 FR 32293
Sei Whale (*Balaenoptera borealis*)	E – 35 FR 18319	-- --	76 FR 43985
Bowhead Whale (*Balaena mysticetes*)	E – 35 FR 18319	-- --	-- --
Sperm Whale (*Physeter macrocephalus*)	E – 35 FR 18619	-- --	75 FR 81584
Marine Mammals - Pinnipeds			
Ringed Seal (*Phoca hispida hispida)* – Arctic DPS	T – 77 FR 76706	-- --	-- --
Sea Turtles			
Green Turtle (*Chelonia mydas*)	E – 43 FR 32800	63 FR 46693	63 FR 28359
Hawksbill Turtle (*Eretmochelys imbricata*)	E – 35 FR 8491	63 FR 46693	57 FR 38818
Kemp's Ridley Turtle (*Lepidochelys kempii*)	E – 35 FR 18319	-- --	75 FR 12496
Leatherback Turtle (*Dermochelys coriacea*)	E – 61 FR 17	44 FR 17710	63 FR 28359
Loggerhead Turtle (*Caretta caretta*) – Northwest Atlantic DPS	E – 76 FR 58868	-- --	63 FR 28359
Fishes			
Shortnose sturgeon (*Acipenser brevirostrum*)	E – 32 FR4001	-- --	63 FR 69613
Gulf sturgeon (*Page: 91 Acipenser oxyrinchus desotoi*)	T – 56 FR 49653	68 FR 13370	Recovery Plan
Atlantic sturgeon (*Acipenser oxyrinchus oxyrinchus*)			
Alantic Sturgeon, Gulf of Maine DPS	T – 77 FR 5880	-- --	-- --
Atlantic Sturgeon, New York Bight DPS	E - 77 FR 5880	-- --	-- --
Atlantic Sturgeon, Chesapeake Bay DPS	E - 77 FR 5880	-- --	-- --
Atlantic Sturgeon, Carolina DPS	E – 77 FR 5914	-- --	-- --
Atlantic Sturgeon, South Atlantic DPS	E – 77 FR 5914	-- --	-- --
Atlantic Salmon – Gulf of Maine DPS	E – 74 FR 29344	74 FR 29300	70 FR 75473
Smalltooth Sawfish (*Pristis pectinata)*	E – 68 FR 15674	74 FR 45353	74 FR 3566
Largetooth Sawfish (*Pristis pristis*)	E – 76 FR 40822	-- --	-- --
Corals			
Elkhorn Coral (*Acropora palmata*)	T – 71 FR 26852	-- --	-- --
Staghorn Coral (*Acropora cervicornis*)	T – 71 FR 26852	-- --	-- --

4.2 Species Proposed for Listing That May be Affected

The U.S. Navy determined that the proposed species listed in Table 29 may be affected by proposed training and testing activities and associated stressors.

Table 29. Species Proposed for Listing Under the ESA that May be Affected by U.S. Navy Atlantic Fleet Training and Testing Activities

Species	ESA Status	Critical Habitat	Recovery Plan
Corals			
Boulder Star Coral (*Montastraea annularis*)	Proposed Endangered 77 FR 73219	-- --	-- --
Elkhorn Coral (*Acropora palmata*)	Proposed Reclassification from Threatened to Endangered 77 FR 73219	73 FR 72210	-- --
Mountainous Star Coral (*Montastraea faveolata*)	Proposed Endangered 77 FR 73219	-- --	-- --
Pillar Coral (*Dendrogyra cylindrus*)	Proposed Endangered 77 FR 73219	-- --	-- --
Rough Cactus Coral (*Mycetophyllia ferox*)	Proposed Endangered 77 FR 73219	-- --	-- --
Staghorn Coral (*Acropora cervicornis*)	Proposed Reclassification from Threatened to Endangered 77 FR 73219	73 FR 72210	-- --
Star Coral (*Montastraea franksi*)	Proposed Endangered 77 FR 73219	-- --	-- --
Lamark's Sheet Coral (*Agaricia lamarki*)	Proposed Threatened 77 FR 73219	-- --	-- --
Elliptical Star Coral (*Dichocoenia stokesii*)	Proposed Threatened 77 FR 73219	-- --	-- --

4.3 Species and Designated Critical Habitat Not Considered Further in this Opinion

As described in the *Approach to the Assessment* section of this Opinion, NMFS uses two criteria to identify those endangered or threatened species or critical habitat that are not likely to be adversely affected by proposed U.S. Navy Atlantic Fleet training and testing. The first criterion is *exposure* or some reasonable expectation of a co-occurrence between one or more potential stressor associated with training and testing activities and a particular listed species or designated critical habitat. If we conclude that a listed species or designated critical habitat is not likely to be exposed to training and testing activities, we must also conclude that the critical habitat is not likely to be adversely affected by those activities. The second criterion is the probability of a *response* given exposure, which considers *susceptibility*. For example, a species may be exposed to noise from explosions of ordnance, but may be unlikely to be affected by the sound (at sound pressure levels they are likely to be exposed to). We applied these criteria to the species listed in Table 28 and Table 29.

4.3.1 **Largetooth Sawfish**

Taxonomy All sawfishes belong to two Genera (*Pristis* and *Anoxypristis*) in the Family Pristidae of the Order Pristiformes, and are classified as rays (Superorder Batoidea). Sawfishes are distinguished from other rays by the long snout (rostrum) with teeth on either side. Using molecular phylogeny (mitochondrial and nuclear gene analysis) paired with morphological characters, Faria (2007) distinguished seven extant species in the Pristidae. Sawfishes are classified into three morphological groups based on rostrum characteristics: Largetooth, smalltooth, and knifetooth (Garman, 1913). Three species are currently classified in the largetooth ''group,'' namely *P. perotteti*,*P. microdon*, and *P. pristis*, though difficulties associated with taxonomic identification are known (Faria 2007) (Wiley *et al.*, 2008, Wueringer *et al.*, 2009).

Pristis perotteti has been referred to by other names throughout its range. For instance, it has been called *P. antiquorum* (Bigelow and Schroeder 1953b), *P. zephyreus* (Beebe and Tee-Van, 1941), *P. pristis* (McEachran and Fechhelm, 1998), or *P.microdon* (Chirichigno and Cornejo. 2001) (Garman, 1913; Fowler, 1941; Vakily *et al.*, 2002). Some scientists consider the eastern Pacific populations to be part of the species *P. microdon* (Chirichigno and Cornejo. 2001) (Garman, 1913; Fowler, 1941), while others consider the eastern Pacific populations to be *P. perotteti* (Compagno and Cook 1995; Cook et al. 2005) (Jordan and Evermann, 1896; refs. in Beebe and Tee-Van, 1941; Camhi *et al.*, 1998). The species are generally classified based upon location (i.e., *P. perotteti* occurs in the Atlantic, while *P. microdon* is in the Indo-Pacific), and there is some evidence that tooth counts may differ (Wueringer *et al.*, 2009). The conserved morphology of sawfishes makes identification difficult in some cases; most species are distinguished by the number of teeth on, and size of, the rostrum, placement of the first dorsal fin in relation to the pectoral fins, and shape of the lower lobe of the caudal fin. However, Faria (2007), used both mitochondrial and nuclear genes to investigate the population structure for all Pristidae. The results from his study indicate that the ''largetooth'' species *P. microdon* and *P. perotteti* are separate species, and that *P. microdon* occurs in the Pacific, based on their mitochondrial deoxyribonucleic acid sequencing data and differences in external morphology (e.g., rostrum length and horizontal length of the eye).

Based on the available taxonomic information on P. perotteti, we have determined the species' range is the eastern and western Atlantic Ocean. The rostral tooth count per side for *P. perotteti* ranges from 14 to 22, and the space between the two most posterior teeth is between 4.5 and 8.5 percent of rostrum standard length (Faria 2007). The origin of the first dorsal fin is forward of the pelvic fin origin, and the lower lobe of the caudal fin is distinct at all maturity stages. The largest known specimen was a 275.6 in (700 cm) total length (TL) female captured in northern Brazilian waters (Almeida 1999). The only other sawfish species that overlaps in range with P. perotteti is the smalltooth sawfish, P. pectinata. These species are differentiated by the number of teeth on the rostrum (22 to 29 per side for P. pectinata (Wiley et al., 2008), and 14 to 22 per side for P. perotteti(Faria 2007)), and the rostrum length of P. pectinata is shorter in relation to its body length.

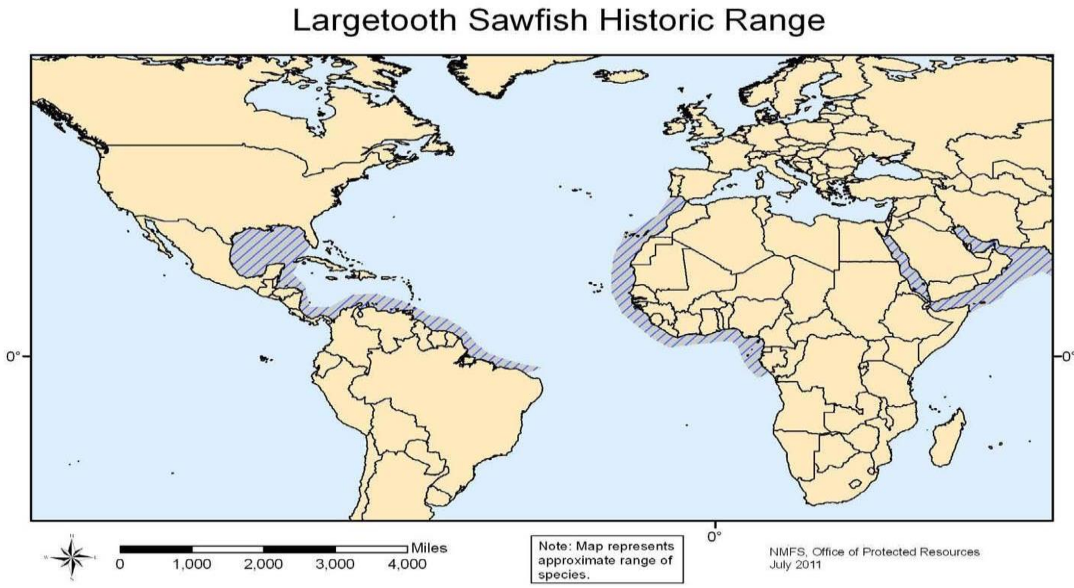

Figure 6. Largetooth Sawfish Historic Range

4.3.1.1 ***Habitat Use and Migration***

Largetooth sawfish are generally restricted to shallow coastal, estuarine, and fresh waters, although they have been found at depths of up to 400 ft (122 m) in Lake Nicaragua. Largetooth sawfish are often found in brackish water near river mouths and large bays, preferring partially enclosed waters, lying in deeper holes and on bottoms of mud or muddy sand (Bigelow and Schroeder 1953b). This species, like the smalltooth sawfish, is highly mangrove-associated (Burgess et al. 2009).

Juvenile smalltooth sawfish are commonly found close to shore on muddy or sandy bottoms (NMFS 2009); however they are commonly observed swimming near the surface in the wild and in aquaria (Cook et al. 2005). Largetooth sawfish move across salinity gradients freely and appear to have more physiological tolerance of freshwater than smalltooth sawfish sand (Bigelow and Schroeder 1953b; Thorson 1974; Thorson 1976b)Dahl, 1971; all as cited in Thorson, 1982a).

Though their habitats once overlapped in the northern Gulf of Mexico, the largetooth sawfish historically had a more southerly range than the smalltooth sawfish, with what appears to be a more narrow seasonal migration pattern. Mature largetooth sawfish seasonally ventured into waters as far north as U.S. waters of the Gulf of Mexico.

4.3.1.2 ***Age and Growth***

There have been no formal studies examining the age and growth of the largetooth sawfish, though Thorson's (1982) study of the Lake Nicaragua population estimated size at birth to be 30 in (75 cm) and an early juvenile growth rate of 13.8 to 15.7 in (35 to 40 cm)/year. Thorson (1982) also estimated age of maturity to be 10 years and size at maturity 118 in (300 cm). Preliminary vertebral growth ring analysis has extrapolated largetooth sawfish (*P. microdon*) lifespan to an estimated maximum age of 51 years (Peverell 2006), and we determined this to be our best available estimate of largetooth sawfish lifespan. Growth rates of captive sawfish in Colombia averaged 7.7 in (19.6 cm) per year (Bohoroquez, 2001).

4.3.1.3 ***Reproductive Biology***

The reproductive method of sawfishes is most likely lecithotrophic viviparity; ova are internally fertilized, developing embryos receive nourishment from an external yolk sac, and the pups are born live after the yolk sac is absorbed. The only known reproductive study of largetooth sawfish was from Lake Nicaragua in the 1970s (Thorson 1976b). This study found that litter size ranged from one to 13 pups, with an average of 7.3 pups per cycle. The gestation period was approximately 5 months, with a biennial reproductive cycle. After gestation, young are born between October and December (Oetinger, 1978). Thorson (1976b) also found that both ovaries appeared to be functional, though the left seemed to be larger and carry more ova. Parturition occurred in October and November and size at birth was between 28.7 and 31.5 in (73 and 80 cm) TL. Thorson (1976b) reported that the smallest gravid female was 120 in (305 cm) TL, and based on this and other observations, reported the size at maturity is estimated to be around 118 in (300 cm) TL. The life history of largetooth sawfish, like most elasmobranchs, is characterized by slow growth, late maturity, and low fecundity, which generally contributes to a low intrinsic rate of population increase.

Simpfendorfer (2000a) estimated that largetooth sawfish in Lake Nicaragua had an intrinsic rate of increase (r) of 0.05 to 0.07 per year, with a population doubling time (t_{x2}) of 10.3 to 13.6 years. Intrinsic rates of increase below 0.1 are considered low, making species particularly vulnerable to population decline (Musick et al. 2000). The results indicated that if effective conservation measures are put in place for the species and its habitats, recovery to levels with little risk of extinction will take many decades. Since Thorson (1973) hypothesized that many Lake Nicaragua sawfish may live their whole lives in the lake and Faria (2007) reported that the Lake Nicaragua sawfish may be a separate stock, the life history parameters estimated by Simpfendorfer (2000a) may be unique to that subpopulation or stock.

4.3.1.4 ***Diet and Feeding***

No published information is available that quantitatively describes the diet of largetooth sawfish. Bigelow and Schroeder (1953b) reported that, in general, sawfish subsist on the most abundant small schooling fishes in the area, such as mullets and small clupeids. There is also some evidence of largetooth sawfish feeding on crustaceans and other small benthic organisms (Bigelow and Schroeder 1953b). In these cases, the rostrum may be used to stir up the bottom sediments to locate prey, and in the case of fish predation, the rostrum may be used to stun or wound the fish in a slashing movement (Bigelow and Schroeder 1953b).

4.3.1.5 ***Predation***

While there is potential for competition between *P. perotteti* and *P. pectinata* due to their overlap in range and habitat types, there is no data to support this, and differences in patterns of habitat use and salinity tolerance may adequately partition the niches of these species. Thorson (1970) speculated that the Lake Nicaragua population may have also competed with the bull shark, *Carcharhinus leucas*, as both were quite prevalent (Thorson, 1970); however, both species have since declined to the point of near extirpation. A *Pristis* species has been documented within the stomach of a bottlenose dolphin near Bermuda (Bigelow and Schroeder 1953b), in the stomach of a bull shark (*C. leucas)* in Australia (Thorburn *et al.*,2004), and a juvenile smalltooth sawfish was captured with fresh bite marks from what appears to be a bull shark (Tonya Wiley, pers. comm., 2009). The International Union for Conservation of Nature (IUCN) Red List for the largetooth sawfish also states that crocodiles prey on the species (Charvet-Almeida *et al.*, 2007).

4.3.1.6 ***Distribution and Abundance***

Historically, *P. perotteti* are thought to inhabit warm temperate to tropical marine waters in the eastern and western Atlantic and Caribbean. In the western Atlantic, *P. perotteti* occurred from the Caribbean and Gulf of Mexico south through Brazil, and in the United States, largetooth sawfish were reported in the Gulf of Mexico, mainly along the Texas coast and east into Florida waters (Burgess et al. 2009) (Burgess and Curtis, 2003). Burgess *et al.* (2009) also state that, based on the evidence, the species rarely occurred in Florida waters and that nearly all records of largetooth sawfish encountered in U.S. waters were limited to the Texas coast. In the eastern Atlantic, *P. perotteti* historically occurred from Spain through Angola.

Currently, *P. perotteti* are thought to primarily occur in freshwater habitats in Central (includes Mexico) and South America and West Africa. In Atlantic drainages, largetooth sawfish have been found in freshwater at least 833 miles (1,340 km) from the ocean in the Amazon River system (Manacapuru, Brazil), as well as in Lake Nicaragua and the San Juan River; the Rio Coco, on the border of Nicaragua and Honduras; Rio Patuca, Honduras; Lago de Izabal, Rio Motagua, and Rio Dulce, Guatemala; the Belize River, Belize; Mexican streams that flow into the Gulf of Mexico; Las Lagunas Del Tortuguero, Rio Parismina, Rio Pacuare, and Rio Matina, Costa Rica; Rio San Juan and the Magdalena River, Colombia; the Falm River in Mali and Senegal; the Saloum River, Senegal; coastal rivers in Gambia; and the Geba River, Guinea-Bissau (Compagno and Cook 1995; Cook et al. 2005; Thorson 1974; Thorson 1982) (Castro-Aguirre, 1978 as cited in Thorson, 1982b).

4.3.1.7 ***The United States***

Although the first confirmed record of a U.S. largetooth sawfish was from ‘‘the Gulf of Mexico’’ in 1878 (Burgess et al. 2009), they were likely present prior to this time period. Sawfish encounters were reported in the entire Gulf of Mexico in early popular literature of the late 1800s but the similarities between the smalltooth and largetooth sawfishes limited the ability of non-specialists to discriminate between the two species. Because of this, there is no conclusive data available for largetooth sawfish abundance before fishing and other anthropogenic pressures began to affect their distribution. Recreational fishers in Texas began targeting prize fishes, including large elasmobranchs such as sawfishes, in the 1930s. Photographs taken of these catches were favored in the print media, allowing Burgess *et al.* (2009), to identify 33 largetooth sawfish in Texas.

Though reported in the United States, it appears that *P. perotteti* was never as abundant as *P. pectinata*, with approximately 39 confirmed records (33 in Texas) from 1910 through 1961, and no confirmed sightings in the years since (Burgess et al. 2009). A 1963 newspaper article reporting a shrimp trawler off the coast of Texas taking a ''broadbill sawfish'' may refer to a largetooth sawfish (Burgess et al. 2009). One specimen was reported between 1916 and 1919 in Louisiana. The capture location and identification as a largetooth sawfish species ''presumably from Alabama'' was catalogued at the University of Alabama but could not be verified (Burgess et al. 2009).

Four individuals from Florida were noted between 1910 and 1960 (Burgess et al. 2009). Two of the reports in Florida were identified by elasmobranch researcher Stewart Springer by rostral tooth counts: One from Key West (1941) and another from Port Salerno (Baughman, 1943) (Bigelow and Schroeder 1953b). Port Salerno is on the east coast of Florida, making this capture the only reported largetooth sawfish outside of the Gulf of Mexico in the United States. Another specimen from south Florida was collected by the American Museum of Natural History in 1910. The final record for *P. perotteti* in Florida was recorded in the Springer and Woodburn (1960) study of Tampa Bay fishes. The dried specimen was on display at the Sea-Orama in the City of Clearwater Beach, but the identification was not verified, and the size of the specimen (Burgess et al. 2009) was much smaller than any other individual captured in U.S. waters. With this exception, all largetooth sawfish captured in the U.S. were 14 feet (4.3 m) in length or larger.

In Texas, largetooth sawfish were primarily found in three regions: Padre Island-Laguna Madre, Corpus Christi-Port Aransas, and Galveston-Freeport (Burgess et al. 2009). Most were caught from 1929 through 1957, though some records may have been duplicated (Baughman, 1943). Ten largetooth sawfish were encountered in the Corpus Christi-Port Aransas region, from 1917 to 1961, though again duplication of records is possible. The highest number of records is from the northeast Texas coast (Galveston) and the lowest number from near the Texas-Mexico border (Padre Island), corresponding to the historical freshwater inflow patterns of the region (Longley, 1994). That is, sighting frequency is positively correlated with higher freshwater flow discharge. While it is likely that the freshwater affinity of this species, especially in comparison to the smalltooth sawfish, attracted the largetooth sawfish to these high outflow areas, these numbers may also be an artifact of higher fishing effort or likelihood of reporting in that area.

Burgess *et al.* (2009) report captures of largetooth sawfish in Texas were primarily in shallow inshore waters and the majority (65 percent) of those captures noted were taken from fisheries using rod and reel gears. Additionally, shrimp nets (reported as shrimp seines, shrimp net, and shrimp trawls) are the gear type associated with approximately 25 percent of all captures. Where size data could be determined, all largetooth sawfish caught in Texas were greater than 16 ft (4.88 m) TL. Burgess *et al.* (2009) report all largetooth sawfish found in U.S. waters were large

(>14 ft (4.3 m)) and were primarily encountered during periods of warm water (May through October), suggesting that adults of this species mainly utilized Texas waters in the summer (but data on month of capture only exist for 10 records). The last confirmed record of *P. perotteti* in U.S. waters was from Port Aransas, Texas on 24 June 1961. The last records for other Gulf of Mexico states include Florida in 1941 and Louisiana in 1917. No records of largetooth sawfish were found from Mississippi, and, as stated previously, the one Alabama specimen could not be verified.

4.3.1.8 ***Summary and Abundance***

The range of the largetooth sawfish has contracted significantly on both sides of the Atlantic. Although no time-series abundance data exists to quantify the extent of the decline of the species throughout its range, we believe that with the substantial number of commercial and recreational fisheries fishing along our U.S. coast, the uniqueness of the species morphology, and because media and internet sites are easily accessible to the public, largetooth sawfish encounters would be noteworthy and reported. Additionally, outreach efforts along the Gulf of Mexico coast in the U.S. for the smalltooth sawfish, which includes printed brochures and signage in local bait shops, marinas, and boat ramps on where and how to report sawfish encounters, should have increased the likelihood of reporting a largetooth sawfish encounter. Access to media and internet sites for reporting largetooth encounters outside the U.S. is most likely less common in some of the remote areas along the coasts of Central America, the Amazonian region of Brazil, and West Africa. Nevertheless, the apparent decrease of sightings over time suggests that the species has undergone severe declines in abundance throughout its range. Moreover, the decline in museum records, negative scientific survey results in the U.S. and Lake Nicaragua, and anecdotal reports from fisher people suggest the trend for the species is declining (Burgess et al. 2009).

4.3.1.9 ***Conclusion***

The U.S. Navy determined that stressors resulting from sonar and other active acoustic sources, explosives, swimmer defense airguns, weapons firing/launch/impact noise, aircraft noise, vessel noise, electromagnetic devices, vessels and in-water devices, and military expended materials may affect, but are not likely to adversely affect largetooth sawfish as the activities would not impose fitness consequences on an individual that could result in "take" due to very low potential for co-ocurrence of individuals and specific stressors. All other stressors were determined to have "no effect" on largetooth sawfish since exposure or response to these potential stressors would not be expected."

We conclude that the training exercises and testing activities the U.S. Navy proposes to conduct in the AFTT Study Area on an annual basis and cumulatively over five years from November 2013 through November 2018, or ongoing for the reasonably foreseeable future, are not likely to adversely affect the largetooth sawfish due to lack of potential for exposure to stressors associated with training and testing. As a result, we will not consider this species in greater detail in the remainder of this Opinion.

4.3.2 Atlantic Salmon-Gulf of Maine DPS

4.3.2.1 *Description of the species*

Gulf of Maine (GOM) DPS Atlantic salmon occur along the Atlantic coast from the Androscoggin River (Maine) in the south to the St. Croix River on the U.S.-Canadian border. The lower Penobscot River has three primary tributaries that contain Atlantic salmon: Cove Brook, Kenduskeag Stream, and Kennebec and Ducktrap rivers. The estimated population of Atlantic salmon in the lower Penobscot River and its tributaries is less than 20 adult Atlantic salmon. Atlantic salmon are also listed in the Denny's River, East Machias River, Machias River, Pleasant River, Narraguagus River, and Sheepscot River.

4.3.2.2 *Distribution*

The Atlantic salmon is an anadromous fish species that is native to the basin of the North Atlantic Ocean from the Arctic Circle to Portugal in the eastern Atlantic Ocean, from Iceland and southern Greenland, and from the Ungava region of northern Quebec south to the Connecticut River (Scott and Crossman 1973). In the U.S., Atlantic salmon historically ranged from Maine south to Long Island Sound. However, the central New England and Long Island Sound DPSs have been extirpated (65 FR 69459).

4.3.2.3 *Habitat*

The salmon's preferred spawning habitat is coarse gravel or rubble substrate (up to 3.5 inches in diameter) with adequate water circulation to keep the buried eggs well oxygenated (Peterson 1978). Water depth at spawning sites is typically between one and 2 feet deep, and water velocity averages 2 feet per second (Beland 1984). Spawning sites, or redds, average 8 feet long and 4.5 feet wide and are often located at the downstream end of riffles where water percolates through the gravel or where upwellings of groundwater occur (Moir et al. 1998). The annual egg production is approximately 240 eggs per 1,075 feet^2 of fluvial habitat (Chaput et al. 1998).

4.3.2.4 *Movement, Growth, and Reproduction*

Adult Atlantic salmon ascend the rivers of New England beginning in the spring and continuing into the fall, with peak numbers occurring in June. Although spawning does not occur until late fall, the majority of Atlantic salmon in Maine enter freshwater between May and mid-July (Aerts et al. 2013; Venn-Watson et al. 2010). Salmon that return in early spring spend nearly 5 months in the river before spawning, often seeking cool water refuge (e.g., deep pools, springs, and mouths of smaller tributaries) during the summer months. Once an adult salmon enters a river, rising river temperatures and water flows stimulate upstream migration. Approximately 80% of salmon return to their home river after two years at sea, measuring approximately 2.5 feet long and weighing approximately 10 pounds (USFWS 2005b). A minority (10 to 20%) of Maine salmon return as smaller fish, or grilse, after only one winter at sea and still fewer return after three years at sea. A spawning run of salmon with representation of several age groups ensures some level of genetic exchange among generations. Once in freshwater, adult salmon cease feeding during their up-river migration. Spawning occurs in late October through November. Spawning sites are positioned within flowing water, particularly where upwelling of groundwater occurs, allowing for percolation of water through the gravel (Venn-Watson et al. 2013). These sites are most often positioned at the head of a riffle (Aerts et al. 2013); the tail of a pool; or the upstream edge of a gravel bar where water depth is decreasing, water velocity is increasing

(Kajan and Saarinen 2013; McLaughlin and Knight 1987), and hydraulic head allows for permeation of water through the redd (a gravel depression where eggs are deposited).

A single female may create several redds before depositing all of her eggs. Female anadromous Atlantic salmon produce a total of 1,500-1,800 eggs per kilogram of body weight, yielding an average of 7,500 eggs per two sea-winter (SW) female (an adult female that has spent two winters at sea before returning to spawn) (Barnes 1992).

After spawning, most Atlantic salmon move immediately downstream to backwater habitats near the head of tide (Cunjak et al. 1998) (Dvoretsky and Dvoretsky 2013). Upon returning to salt water, the spawned salmon or kelt resume feeding. If the salmon survives another one or two years at sea, it will return to its home river as a repeat spawner. From 1967 to 2003, approximately 3% of the wild and naturally reared adults that returned to rivers where adult returns are monitored--mainly the Penobscot River--were repeat spawners (Hardack 2013). Hatchery fish also return to the rivers into which they are stocked (Gorsky et al. 2009).

In late March or April, the eggs hatch into alevins. Alevins remain in the redd for about six weeks and are nourished by their yolk sac. Alevins emerge from the gravel about mid-May, generally at night, and begin actively feeding (Redfern et al. 2013). Survival from the egg to fry stage in Maine is estimated to range from 15-35% (Robertson et al. 2013). Survival rates of eggs and larvae are a function of stream gradient, overwinter temperatures, interstitial flow, predation, disease, and competition (Day et al. 2013). Once larval fry emerge from the gravel and begin active feeding they are referred to as fry. The majority of fry (>95%) emerge from redds at night (Castellini 2012). The survival rate of fry is affected by stream gradient, overwintering temperatures and water flows, and the level of predation and competition (Bley and Moring 1988).

Within days, the free-swimming fry enter the parr stage, moving downstream to areas with adequate cover (rocks, vegetation, overhanging banks, and woody debris), water depths ranging from approximately four to 24 inches, velocities between 1foot and 3 feet per second, and temperatures near 61ºF (Beland 1984). When they finally reach their desired habitats, parr will actively defend territories that vary in size depending on the amount of food available and the density of other parr in the area (Armstrong et al. 1999; McCormick et al. 1998; Symons 1971). Some male parr become sexually mature and can successfully spawn with sea-run adult females. Water temperature, appetite, parr density, photoperiod, the level of competition and predation, and food supply may all influence the growth rate of parr (Elliot 1991; Fausch 1988; Hearn 1987; Lundqvist 1980; Metcalfe et al. 1988; Nicieza and Metcalfe 1997; Randall 1982). Maine Atlantic salmon parr densities are typically between three and nine parr per 1,075 feet^2, with years up to 16 parr per 1,075 feet^2 not uncommon (Beland 1996). There is no evidence of density-dependent limitations at densities of 13 parr per 1,075 feet^2 (Whalen et al. 2000). Parr feed on larvae of mayflies, stoneflies, caddisflies, chironomids, blackflies, annelids, and mollusks, as well as numerous terrestrial insects that fall into the river (Scott and Crossman 1973).

In a parr's second or third spring, when it has grown 5 to 6 inches long, physiological, morphological, and behavioral changes occur (Schaffer and Elson 1975). This process, called smoltification, prepares parr for the dramatic change in osmoregulatory needs that comes with the transition from a freshwater to a saltwater habitat (Hoar 1976; McCormick et al. 1998; McLeese et al. 1994). In southern latitudes, including New England, most parr smolt after one year, but in cooler areas, they may take two to four years in freshwater before smolting ((McCormick et al. 1998). Most smolts in New England rivers enter the sea during May and June to begin their ocean migration. Maine rivers produce approximately three smolts per 1,075 $feet^2$ of habitat.

Atlantic salmon of U.S. origin are highly migratory, undertaking long marine migrations from the mouths of U.S. rivers into the northwest Atlantic Ocean, where they are distributed seasonally over much of the region (Reddin 1985). The marine phase starts with smoltification and subsequent migration through the natal river and estuary. Upon completion of the physiological transition to saltwater, the post-smolt stage grows rapidly and has been documented moving in small, loosely aggregated schools near the surface (Dutil and Coutu 1988). After entering the nearshore waters of Canada, the post-smolts become part of a mixture of stocks of Atlantic salmon from various North American streams. Post-smolts appear to feed opportunistically on macroinvertebrates, amphipods, euphausiids, and fish (Andreassen et al. 2001; Hansen and Pethon 1985; Hansen and Quinn 1998). Once they mature to adult salmon, they travel individually and primarily eat capelin, herring, and sand lance (Hansen and Pethon 1985; Hansen and Quinn 1998; Reddin 1985).

4.3.2.5 *Status and Trends*

The GOM DPS of anadromous Atlantic salmon was listed by the USFWS and NMFS as an endangered species on November 17, 2000 (65 FR 69495). The GOM DPS encompasses all naturally reproducing remnant populations of Atlantic salmon downstream of the former Edwards Dam site on the Kennebec River northward to the mouth of the St. Croix River. To date, Atlantic salmon are listed in the Denny's, East Maccias, Machias, Pleasant, Narraguagus, Ducktrap, and Sheepscot Rivers, Kenduskeag Stream, and Cove Brook. Naturally reproducing Atlantic salmon in the Penobscot River and its tributaries downstream of the former Bangor Dam are listed as endangered. The USFWS's GOM DPS river-specific hatchery-reared fish are also included as part of the listed entity (73 FR 51415).

Anadromous Atlantic salmon were native to nearly every major coastal river north of the Hudson River, New York (USFWS 2005b). The annual historic Atlantic salmon adult population returning to U.S. rivers has been estimated to be between 300,000 and 500,000 (Beland 1984; Stolte 1981). The largest historical salmon runs in New England were likely in the Connecticut, Merrimack, Androscoggin, Kennebec, and Penobscot Rivers.

By the early 1800s, Atlantic salmon runs in New England had been severely depleted, reducing the distribution in the southern half of its range. Restoration efforts were initiated in the mid-1800s, but there was little success (Stolte 1981). There was a brief period of success in the late 19^{th} century when limited runs were reestablished in the Merrimack and Connecticut Rivers by artificial propagation, but these runs were extirpated by the end of the century. By the end of the

19th century, three of the five largest salmon populations in New England (Connecticut, Merrimack, and Androscoggin Rivers) had been eliminated.

Abundance of adult Atlantic salmon is estimated using traps at a fishway, or through redd (nest) counts. Total trap counts, which include wild and hatchery fish, and total number of redds counted in GOM DPS between 1997 and 2004 are depicted in Figure 7. Such counts typically underestimate the actual returns of Atlantic salmon, but can give an idea of trends over time for index reaches and watershed. Juvenile smolt production is another measure of population trends, growth rate, and densities.

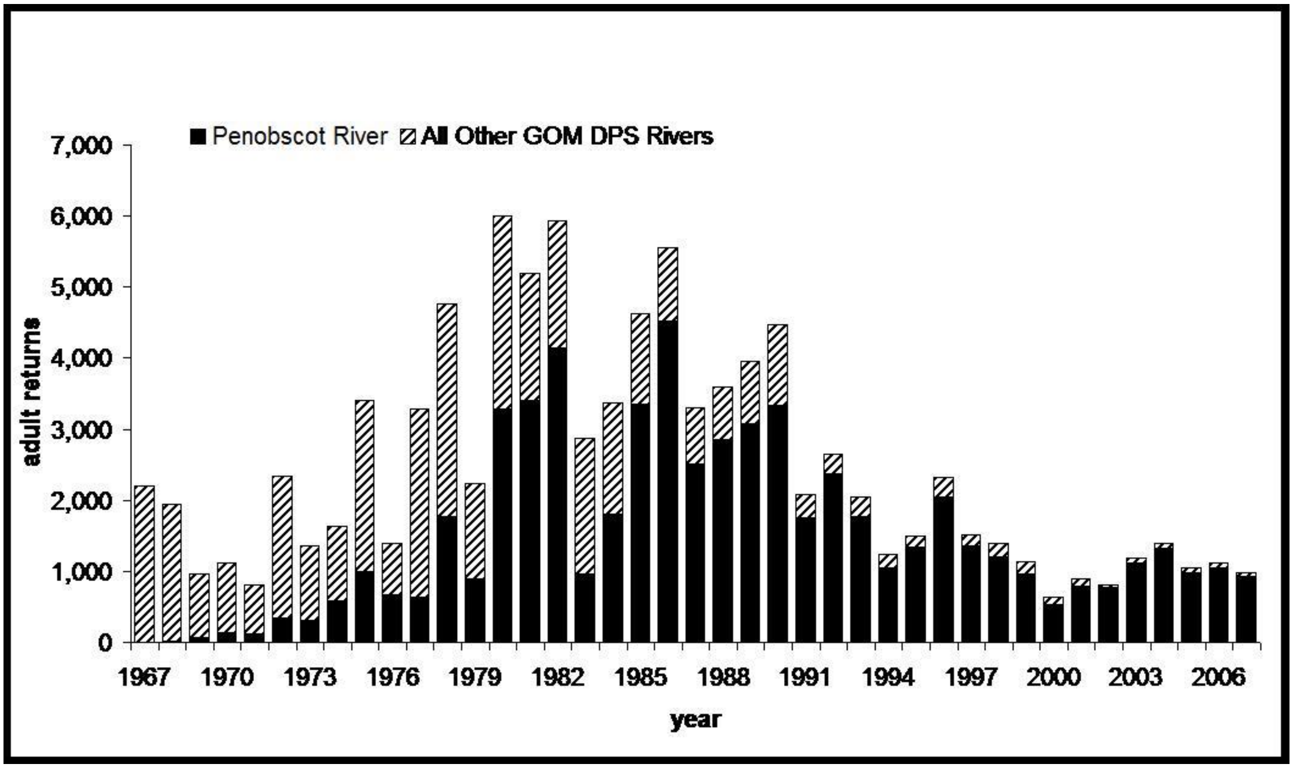

Figure 7. Adult returns to the GOM DPS 1967-2007.

Recently, Fay et al. (2006) used Population Viability Analysis (PVA) techniques to determine the conservation status of Atlantic salmon in the GOM DPS. Composite spawner data used to populate the model included adult return and rod kill estimates from the Penobscot River, adult spawner and rod kill estimates for the Narraguagus River, and adult spawner estimates for the GOM DPS. Using two time series, 1984 to 2004 and 1991 to 2004, Fay et al. (2006) calculated the negative population growth rates (for 1980-2004, lambda = 0.9690, variance = 0.0261; for 1991-2004, lambda = 0.9471, variance = 0.0142). From this, the estimated risk of extinction (defined herein as the number of spawners that falls below 100 individuals) within 100 years is 61% and 75% (or 28% and 45% in 40 years), for each respective data set.

4.3.2.6 ***Natural Threats***

Geographic features, such as waterfalls, pose natural barriers to salmon migration to spawning habitat. A variety of diseases affect Atlantic salmon, but are exacerbated by the presence of farming pens near river mouths. Atlantic salmon are prey for a variety of predators, including seals, porpoises, dolphins, otters, minks, birds, sharks, and a variety of other fishes at various salmon life stages.

4.3.2.7 ***Anthropogenic Threats***

Humans pose numerous threats to Atlantic salmon survival and recovery (see USFWS 2005b for a review). Water quality in both marine, estuarine, and aquatic habitats suffers from both point and non-point source pollution, both biological (bacteria) and chemical. Riverine environments are becoming acidified, which can cause physiological stress in adults and altered developmental biology in eggs or hatchlings. In association with acidification, aluminum toxicity can lead to osmoregulation failure. This is because Atlantic salmon are highly sensitive to pH changes and many runs of Atlantic salmon in Sweden, Norway, and Canada have been severely depleted or extirpated due to acidity changes in river systems resulting from industrial activity (Sandøy and Langåker 2001; Watt 1981; Watt et al. 1983; Watt et al. 2000). Pesticide use and its immigration into Maine waterways is also of concern. For example, atrazine can significantly impair water balance in salmon even at low concentrations, resulting in a reduced ability for salmon to move between fresh and salt water (Jagoe and Haines 1990; Staurnes et al. 1993; WWF 2001). At levels that presently occur in stream environments, male salmon also experience impaired olfactory reception in being able to detect female pheromones (Waring and Moore 1998). Thus, male reproduction activity is not cued to that of females and has the potential to severely reduce recruitment. Nonylphenols are also severely detrimental to juvenile salmon. These chemicals also reduce the ability of smolts to transition between fresh and salt water, leading to mortality, as well as imitate female hormones leading to eggs that do not hatch (Fairchild et al. 1999; WWF 2001). Sedimentation due to erosion and development in and around aquatic waterways can degrade salmon habitat and the habitat of their invertebrate prey. Excessive nutrient load, as in marine systems, can lead to a bloom of plant growth and subsequent death, which reduces oxygen levels to anoxic conditions. This can lead to extensive habitat loss and salmon mortality.

Although changes overtly seem minor, increases in Maine's river temperatures can have broad impacts on salmon recovery, including changes in fish physiology, prey abundance and distribution, loss of spawning activity, and other effects (Holbrook et al. 2009; USFWS 2005b). As in Pacific salmon species, Atlantic salmon decline originated largely from manmade barriers across rivers preventing movement to and from spawning and marine habitats. Although many of these barriers have since been modified or removed, modern construction (bridges, culverts, etc.) that do not consider Atlantic salmon needs can hinder recovery efforts (Holbrook et al. 2009). When water temperatures exceed 22º C during spawning runs, Atlantic salmon tend to have poorer success in passing obstacles than (Holbrook et al. 2009).

Atlantic salmon fisheries have been discontinued in the U.S., Canada, and Greenland. A high threat is posed by farm-raised salmon due to the potential for these fish to escape (instances of thousands of fish escaping are known) and interbreed with wild salmon, thereby affecting the genetics of Atlantic salmon as a species. Recent evidence shows that supportive breeding programs, where wild Atlantic salmon are captured and bred in captivity and young are released early in life, produce fish that are genetically, morphologically, and behaviorally different from truly wild progeny (Blanchet et al. 2008). The presence of disease and parasites in farm-raised salmon pens can also have a deleterious effect on wild Atlantic salmon.

Climate change has the potential to be a strong negative influence on Atlantic salmon. Remaining occupied habitat is at the southern edge of the ESU's range. To survive, populations have adapted to distinct physical and environmental conditions here (Saunders 1981). Climate models predict significant, extended warming (IPCC 2001b). Although periods of North Atlantic warming and cooling have occurred, changes have not been uniform as global warming is, changing sea temperatures, wind currents, fresh water input, and mixing of the ocean's surface layer. Small thermal changes can critically affect biological functions, such as protein metabolism, response to aquatic contaminants, reproductive performance, smolt development, and species distribution limits (Keleher and Rahel 1996; McCormick et al. 1997; Reid et al. 1997; Somero and Hofmann 1997; Van der Kraak and Pankhurst 1997; Welch et al. 1998). Atlantic salmon smolt growth is known to change with temperature, with a temperature increase from 57º to 64ºF resulting in a greater than 10% decrease in growth rate (Handeland et al. 2008).

It should be noted that positive effects may also be realized by climate change and specifically warmer water temperature. Increased opportunities for growth in spring and summer could increase the percentage of fish that enter the upper size distribution of a population and smolt the following spring (Thorpe 1977; Thorpe 1994; Thorpe et al. 1980). In addition, warmer rearing temperatures during the late winter and spring have been shown to advance the timing of the parr-smolt transformation in Atlantic salmon (Solbakken et al. 1994). There is, however, an optimal temperature range and a limit for growth after which salmon parr will stop feeding due to thermal stress. During this time, protein degradation and weight loss will increase with rising water temperature (McCarthy and Houlihan 1997). The NRC (2004) concluded that some degree of climate warming or change in hydrologic regime could be tolerated if other problems affecting Atlantic salmon are reduced.

4.3.2.8 *Atlantic Salmon- Gulf of Maine DPS, Critical Habitat*

On 19 June 2009, 45 specific areas occupied by Atlantic salmon at the time of listing (approximately 19,571 km of perennial river, stream, and estuary habitat and 799 square kilometers of lake habitat within the range of the GOM DPS) were established for Atlantic salmon critical habitat (74 FR 29300). Navy facilities including the Bath Ironworks ship building facility were excluded from this designation.

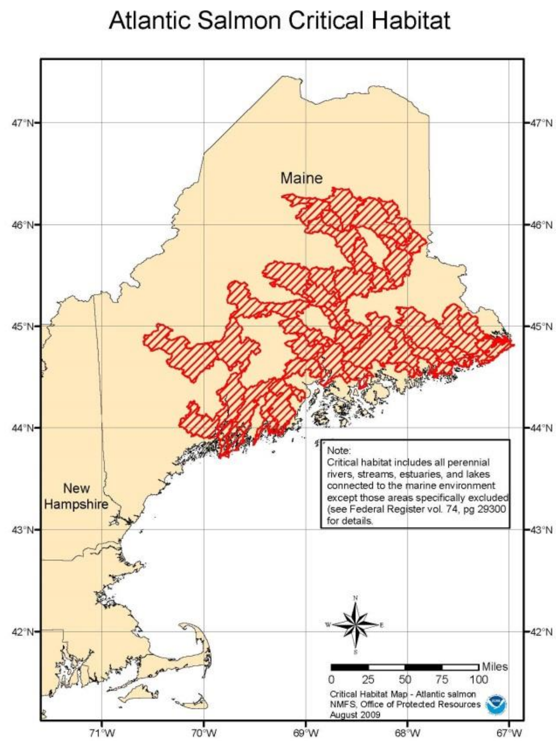

Figure 8. Atlantic Salmon –Gulf of Maine DPS Critical Habitat

The Primary Constituent Elements (PCEs) for this critical habitat include:

- Deep, oxygenated pools and cover (e.g., boulders, woody debris, vegetation, etc.), near freshwater spawning sites, necessary to support adult migrants during the summer while they await spawning in the fall.
- Freshwater spawning sites that contain clean, permeable gravel and cobble substrate with oxygenated water and cool water temperatures to support spawning activity, egg incubation, and larval development as well as support emergence, territorial development and feeding activities of Atlantic salmon fry.
- Freshwater rearing sites with space to accommodate growth and survival of Atlantic salmon parr.
- Freshwater rearing sites with a combination of river, stream, and lake habitats that accommodate parr's ability to occupy many niches and maximize parr production.
- Freshwater rearing sites with cool, oxygenated (6 mg/L) water and diverse food resources (mayflies, stoneflies, chironomids, caddisflies, blackflies, aquatic annelids, and mollusks, as well as numerous terrestrial invertebrates, alewives, dace, or minnows) to support growth and survival of Atlantic salmon parr.

- Freshwater and estuary migratory sites free from physical and biological barriers that delay or prevent access of adult salmon seeking spawning grounds needed to support recovered populations or prevent emigration of smolts to the marine environment.
- Freshwater and estuary migration sites with pool, lake, and instream habitat that provide cool, oxygenated water and cover items (e.g., boulders, woody debris, and vegetation) to serve as temporary holding and resting areas during upstream migration of adult salmon.
- Freshwater and estuary migration sites with abundant, diverse native fish communities to serve as a protective buffer against predation.
- Freshwater and estuary migration sites with sufficiently cool water temperatures and water flows that coincide with diurnal cues to stimulate smolt migration.
- Freshwater migration sites with water chemistry (particularly pH) needed to support sea water adaptation of smolts.

These PCEs have undergone significant degradation over in the recent past. Acidification is one of the greatest threats to salmon and their habitat. Ongoing concerns exist over the role global warming may play in salmon survival, as increases in temperature can affect salmon development and survival. Also, contaminants from runoff and discharges into freshwater streams and lakes have raised concern on bioaccumulation in the food chain and into top level predators, such as Atlantic salmon.

4.3.2.9 ***Conclusion***

The U.S. Navy determined that stressors resulting from sonar and other active acoustic sources, explosives, swimmer defense airguns, weapons firing/launch/impact noise, aircraft noise, vessel noise, vessels and in-water devices, and military expended materials may affect, but are not likely to adversely affect Atlantic salmon by imposing fitness consequences on an individual that could result in “take.” All other stressors were determined to have “no effect” on Atlantic salmon since exposure or response to these potential stressors would not be expected.

We conclude that co-occurrence between potential stressors associated with training and testing activities and Atlantic salmon is possible for active sonar and other acoustic sources, explosives and other impulsive sources, vessels and in-water devices, military expended materials, fiber optic cables and guidance wires, parachutes, munitions and other military expended materials; however, we do not anticipate exposures. Because of their coastal distribution, Atlantic salmon are not likely to be exposed to stressor associated with the training activities the U.S. Navy conducts on the Northeast Operating Areas or the Virginia Capes, Cherry Point, or Jacksonville Range Complex. Additionally, Atlantic salmon are unable to detect the sound produced by mid- or high-frequency sonar and other active acoustic sources. Low-frequency active sonar and other active acoustic sources are not typically operated in the Northeast Range Complexes or in coastal or nearshore waters. If low frequency sources are used in the Northeast Range Complexes, then adult Atlantic salmon in the open ocean could be exposed to sound within their hearing range within these areas. However, the probability of co-occurrence between the activity and species is very low. Therefore acoustic impacts from these sources are not expected.

The primary exposure to vessel and aircraft noise would occur around the Navy ranges, ports, and air bases. Vessel and aircraft overflight noise have the potential to expose Atlantic salmon to sound and general disturbance, potentially resulting in short-term behavioral responses. Atlantic salmon are more susceptible to encounters with these sounds since they typically travel in schools within the top 10 ft. (3 m) of the water column (Hedger et al. 2009). However, the likelihood of co-ocurrence of these stressors and species during training and testing events is low.

While the entire Kennebec River system surrounding the shipyard is considered critical habitat for the species as a result of its use as a spawning and nursery area, the shipyard in Bath, Maine has been excluded for national security reasons. The designated primary constituent elements (sites for spawning and incubation, sites for juvenile rearing, and sites for migration) for Atlantic salmon critical habitat do not occur within the Study Area and therefore, the proposed training activities would not affect the critical habitat. Therefore, Atlantic salmon and designated critical habitat are not carried forward in our analysis in this Opinion.

4.3.3 **Shortnose Sturgeon**

Shortnose sturgeon occur along the Atlantic Coast of North America, from the St. John River in Canada, south to the St. John's River in Florida. NMFS' recovery plan (1998d) recognized 19 wild populations based on their strong fidelity to their natal streams, and several captive populations (from a Savannah River broodstock) that are maintained for educational and research purposes (NMFS 1998d) (Table 11). Although these populations are geographically isolated, genetic analyses suggest that individual shortnose sturgeon move between some of these populations each generation (Quattro 2002; Wirgin et al. 2005b).

4.3.3.1 ***Distribution***

Shortnose sturgeon occur along the Atlantic Coast of North America, from the St. John River in Canada to the St. John's River in Florida. At the northern end of the species' distribution, the highest rate of gene flow (which suggests migration) occurs between the Ponobscot and Androscoggin Rivers. At the southern end of the species' distribution, populations south of the Pee Dee River appear to exchange between one and 10 individuals per generation, with the highest rates of exchange between the Ogeechee and Altamaha Rivers (Wirgin et al. 2005b). Wirgin *et al.* (2005) concluded that rivers separated by more than 250 miles were connected by very little migration while rivers separated by no more than 12 miles (such as the rivers flowing into coastal South Carolina) would experience high migration rates. Coincidentally, at the geographic center of the shortnose sturgeon range, there is a 250 mile stretch of river with no known populations occurring from the Delaware River, New Jersey to Cape Fear River, North Carolina (Kynard 1997a). However, shortnose sturgeon are known to occur in the Chesapeake Bay, and may be transients from the Delaware River via the Chesapeake (Skjeveland et al. 2000; Welsh et al. 2002a) or remnants of a population in the Potomac River (Kynard *et al.* 2009).

Rogers and Weber (1995a), Kahnle *et al.* (1998a), and Collins *et al.* (2000b) concluded that shortnose sturgeon are extinct from the St. Johns River in Florida and the St. Marys River along the Florida and Georgia border. In 2002, a shortnose sturgeon was captured in the St. Johns River, Florida, suggesting either immigration or a small remnant population (FFWCC 2007d).

Rogers and Weber (1995a) also concluded that shortnose sturgeon have become extinct in Georgia's Satilla River.

Table 30. Shortnose sturgeon populations and their estimated abundances.

Population (Location)[a]	Data Series	Abundance Estimate (C.I.)[b]	Population Segment	Reference
Saint John River (Canada)	1973-1977	18,000 (+/-30%)	Adults	Dadswell (1979) COSEWIC (2005b)
Kennebecasis River (Canada)	1998-2005	2,068 (801-11,277)		
Kennebecasis River	2005	4,836 (+/-69)		Li *et al.* (2007)
Penobscot River (ME)	2006-2007	1,049 (673-6,939)		UME 2008
	2008	1739 (846-3653)	Summer	P. Dionne, pers. comm..
		667 (451-1013)	Fall	P. Dionne, pers. comm..
Kennebec River (ME)	1977-1981	7,222 (5,046-10,765)	Adult	Squiers *et al.* (1982)
	2003	9,488 (6,942-13,358)	Adults	Squiers (2003)
Merrimack River (MA)	1987-1991	32 (20-79)	Adults	Kynard & Kieffer, unpubl.; NMFS unpubl.
Connecticut River (MA, CT)	1989-2002	1,042-1,580 [c]	Adults	Savoy (2004)
Upper Connecticut River[d]	1976-1977	516 (317–898)	Total	Taubert (1980); NMFS (1998b)
	1977-1978	370 (235–623)	Total	Taubert (1980); NMFS (1998b)
	1976-1978	714 (280-2,856)	Total	Taubert (1980); NMFS (1998b)
	1976-1978	297 (267–618)	Total	Taubert (1980); NMFS (1998b)
	1994	328 (188-1,264)	Adults	Kynard & Kieffer, unpubl.; NMFS unpubl.
	1994-2001	143 (14-360)	Spawning Adults	Kynard & Kieffer, unpubl.; NMFS unpubl.
Lower Connecticut River[e]	1988-1993	895 (799-1,018)	Adult	Savoy and Shake (1992); NMFS (1998b)
Hudson River (NY)	1980	30,311	Total	Dovel (1979); NMFS (1998b)
	1994-1997	61,057 (52,898-72,191)	Total	Bain *et al.* (2007)
Delaware River (NJ, DE, PA)	1981-1984	12,796 (10,288-16,267)	Partial	Hastings *et al.* (1987)
	1981-1984	14,080 (10,079-20,378)	Partial	Hastings *et al.* (1987)
	1999-2003	12,047 (10,757-13,589)		Brundage and O'Herron (2003)
Chesapeake Bay (MD, VA)				
Cape Fear River (NC)				
Winyah Bay (NC, SC)				
Santee River (SC) Cooper River (SC) ACE Basin (SC)	1996-1998	300	Adults	Cooke *et al.* (2004)
Savannah River (SC, GA)		1,000 - 3,000	Adults	B Post, SCDNR 2003; NMFS unpubl.
Ogeechee River (GA)	1993	266 (236 – 300)		Weber (1996)Weber 1998;

	1993	361 (326 – 400)	Total	Rogers and Weber (1995b) 1994, NMFS (1998b)
	1999-2004	147 (104-249)		Fleming *et al.* (2003); NMFS unpubl.
Altamaha River (GA)	1988	2,862 (1,069 - 4,226)	Total	NMFS (1998b)
	1990	798 (645 - 1,045)	Total	NMFS (1998b)
	1993	468 (316 – 903)	Total	NMFS (1998b)
		6,320 (4,387-9,249)	Total	DeVries (2006)
Satilla River (GA)				
Saint Mary's River (FL)				
Saint Johns River (FL)				FFWCC (2007c)

[a]The original 19 populations identified by NMFS in the 1998 recovery plan are left aligned in this column. Estimates for a tributary or river segment are indented.
[b]Population estimates are established using different techniques and should be viewed with caution. In some cases, sampling biases may have violated the assumptions of the procedures used or resulted in inadequate representation of a population segment. Some estimates (e.g., those without confidence intervals or are depicted by ranges only) are the "best professional judgment" of researchers based on their sampling effort and success.
[c]Range represents total population estimates using four different techniques. All techniques suggest the population increased during the sampling period (see Savoy (2004) for more details).
[d]Above Holyoke Dam.
[e]Below Holyoke Dam.

4.3.3.2 *Status and trends*

Shortnose sturgeon were listed as endangered on 11 March 1967, under the Endangered Species Preservation Act (32 FR 4001) and remained on the endangered species list with enactment of the ESA of 1973, as amended. Although the original listing notice did not cite reasons for listing the species, a 1973 Resource Publication issued by the U.S. Department of Interior (USDOI), stated that shortnose sturgeon were "in peril ... gone in most of the rivers of its former range [but] probably not as yet extinct" (USDOI 1973). Pollution and overfishing, including bycatch in the shad fishery, were listed as principal reasons for the species' decline. Shortnose sturgeon are listed as an endangered species throughout all of its range.

Northern shortnose sturgeon population abundances are generally larger than southern populations (Kynard 1997b). Updated population estimates also suggest that three of the largest populations (Kennebec, Hudson, and Delaware River) may be increasing or stable, although data is limited. The New York (Hudson River) shortnose sturgeon population is the largest extant population of this species and based on available data exhibits appears to have increased (NMFS 1998d) (Bain et al. 2000). The most recent population estimate indicates this population consists of about 61,000-shortnose sturgeon (95 percent confidence interval [CI] was between 52,898 and 72,191 fish (Bain et al. 2000)). A comparison of the Bain estimate to the 1979/1980 population estimate of spawning adults by Dovel *et al.* (1992); about 13,000 fish) led Bain *et al.* (2000) to conclude that the population had made a dramatic increase (about 400 percent increase) between 1979 and 1997. While still evidence of an increasing population, a comparison of total population estimates (30,000:60,000) would suggest the population has only doubled in size during the study years. Similarly, the Kennebec River population appears to be increasing. Early estimates suggest that the Kennebec River contained an estimated 7,200 adult shortnose sturgeon in 1977-81 (Squiers et al. 1982), while the most recent estimate for this population is about 9,500 fish (Squiers 2003), suggesting the population has increased by about 30 percent in about a twenty year period.

Data from the Delaware River, suggests that the population may be stable. Brundage and O'Herron (2006) estimate that the current population for the Delaware River is 12,047 adult fish (1999-2003; 95 percent CI: 10,757-13,589), which is similar to the 1981/84 estimate by Hastings *et al.* (1987) of 12,796 fish (95 percent CI: 10,288-16367). The recent capture of several fish that were tagged as adults by Hastings *et al.* (1987) suggests that older fish may comprise a substantial portion of the Delaware River population. Based on studies from other sturgeon species we know of no evidence of senescence in sturgeon, and we would expect that these fish are reproductively active (Paramian *et al.* 2005). Despite their longevity, the viability of sturgeon populations is sensitive to variability in juvenile recruitment and survival (Anders *et al.* 2002; Gross *et al.* 2002; Secor *et al.* 2002). Although interannual variation in juvenile recruitment would be expected as a result of stochastic factors that influence spawning and egg/larval survival, if the mean population size does not change over the long-term then it would appear there is sufficient juvenile survival to provide at least periodic recruitment into the adult age classes. Data on juvenile recruitment or age-1+ survival would, however, establish whether this population is at a stable equilibrium.

South of Chesapeake Bay, populations are relatively small compared to their northern counterparts. The largest of the southern populations of shortnose sturgeon is the Altamaha River population. Population estimates have been calculated several times for sturgeon in the Altamaha since 1993. Total population estimates shown pretty sizeable interannual variation is occurring; estimates have ranged from as low as 468 fish in 1993 to over 6,300 fish in 2006 (DeVries 2006; NMFS 1998b). The Ogeechee River is the next most studied river south of Chesapeake Bay, and abundance estimates indicate that the shortnose sturgeon population in this river is considerably smaller than that in the Altamaha River. The highest point estimate in 1993 using a modified Schnabel technique resulted in a total population estimate of 361 shortnose sturgeon (95 percent CI: 326-400). In contrast the most recent survey resulted in an estimate of 147 shortnose sturgeon (95 percent CI: 104-249), suggesting that the population may be declining.

Annual variation in population estimates in many basins is due to changes in yearly capture rates, which are strongly correlated with weather conditions (river flow and water temperatures). In "dry years" fish move into deep holes upriver of the saltwater/freshwater interface, which can make them more susceptible to gillnet sampling. Consequently, rivers with limited data sets among years and limited sampling periods within a year may not offer a realistic representation of the size or trend of the shortnose sturgeon population in the basin. As a whole, the data on shortnose sturgeon populations is rather limited and some of the differences observed between years may be an artifact of the models and assumptions used by the various studies. Long-term data sets and an open population model would likely provide for more accurate population estimates across the species range, and could provide the opportunity to more closely link strong-year classes to habitat conditions.

Throughout the species' range there are other extant populations, or at least evidence that several other basins are used periodically. That is, shortnose sturgeon have been documented in the St. John's River (FL), the St. Mary's River, Chesapeake Bay, Potomac River, Piscataqua River, the Housatonic River, and others. Some basins probably previously contained shortnose populations, but recent sampling has been largely unsuccessful. Despite the occasional observations of shortnose sturgeon, populations may be extinct in several basins (e.g., St. John's (FL), St. Mary's, Potomac, Housatonic, and Neuse rivers). Those few fish that have been observed in these basins are generally presumed to be immigrants from neighboring basins. In some cases, (e.g. Chesapeake Bay) migratory information collected from tagged fish and genetic evidence confirms that fish captured in Chesapeake Bay were part of the Delaware River population (Grunwald et al. 2002; Wirgin et al. 2005a)(T. King, in progress).

4.3.3.3 ***Critical habitat***

Critical habitat has not been established for shortnose sturgeon.

4.3.3.4 ***Conclusion***

The U.S. Navy determined that stressors resulting from sonar and other active acoustic sources, explosives, swimmer defense airguns, weapons firing/launch/impact noise, aircraft noise, vessel noise, electromagnetic devices, vessels and in-water devices, military expended materials, and seafloor devices may affect, but are not likely to adversely affect shortnose sturgeon.

The likelihood of exposure of shortnose sturgeon to stressors associated with U.S. Navy training and testing activities is very low based on the low numbers of shortnose sturgeon that may occur in the action area during training and testing events. As such exposure and subsequent response to potential stressors from training and testing activities are not likely. Therefore, shortnose sturgeon will not be considered further in this Opinion.

4.3.4 **Multiple Coral Species**

4.3.4.1 ***Coral Species Information***

Corals are marine invertebrates in the phylum Cnidaria that occur as polyps, usually forming colonies of many clonal polyps on a calcium carbonate skeleton. The Cnidaria include true stony corals (class Anthozoa, order Scleractinia), the blue coral (class Anthozoa, order Helioporacea), and fire corals (class Hydrozoa, order Milleporina). Members of these three orders are represented among the 82 candidate coral species (79 Scleractinia, one Helioporacea, and two Milleporina). All 82 candidate species are reef-building corals, because they secrete massive calcium carbonate skeletons that form the physical structure of coral reefs. Reef-building coral species collectively produce coral reefs over time in high-growth conditions, but these species also occur in non-reef habitats (*i.e.*, they are reef-building, but not reef-dependent). There are approximately 800 species of reef-building corals in the world.

Most reef-building coral species are in the order Scleractinia, consisting of over 25 families, 100 genera, and the great majority of the approximately 800 species. Most Scleractinian corals form complex colonies made up of a tissue layer of polyps (a column with mouth and tentacles on the upper side) growing on top of a calcium carbonate skeleton, which the polyps produce through the process of calcification. Scleractinian corals are characterized by polyps with multiples of six tentacles around the mouth for feeding and capturing prey items in the water column. In contrast, the blue coral, *Heliopora coerulea,* is characterized by polyps always having eight tentacles, rather than the multiples of six that characterize stony corals. The blue coral is the only species in the suborder Octocorallia (the "octocorals") that forms a skeleton, and as such is the primary octocoral reef-building species. Finally, *Millepora* fire corals are also reef-building species, but unlike the scleractinians and octocorals, they have near microscopic polyps containing tentacles with stinging cells.

Reef-building coral species are capable of rapid calcification rates because of their symbiotic relationship with single-celled dinoflagellate algae, zooxanthellae, which occur in great numbers within the host coral tissues. Zooxanthellae photosynthesize during the daytime, producing an abundant source of energy for the host coral that enables rapid growth. At night, polyps extend their tentacles to filter-feed on microscopic particles in the water column such as zooplankton, providing additional nutrients for the host coral. In this way, reef-building corals obtain nutrients autotrophically (*i.e.,*via photosynthesis) during the day, and heterotrophically (*i.e.,* via predation) at night. In contrast, non-reef-building coral species do not contain zooxanthellae in their tissues, and thus are not capable of rapid calcification. Unlike reef-building corals, these "azooxanthellate" species are not dependent on light for photosynthesis, and thus are able to occur in low-light habitats such as caves and deep water. We provide additional information in the following sections on the biology and ecology of reef-building corals and coral reefs.

4.3.4.1.1 Reproductive Life History

Corals use a number of diverse reproductive strategies that have been researched extensively; however, many individual species' reproductive modes remain poorly described. Most coral species use both sexual and asexual propagation. Sexual reproduction in corals is primarily through gametogenesis (*i.e.,* development of eggs and sperm within the polyps near the base). Some coral species have separate sexes (gonochoric), while others are hermaphroditic. Strategies for fertilization are either by "brooding" or "broadcast spawning" (*i.e.,* internal or external fertilization, respectively). Brooding is relatively more common in the Caribbean, where nearly 50 percent of the species are brooders, compared to less than 20 percent of species in the Indo-Pacific. Asexual reproduction in coral species most commonly involves fragmentation, where colony pieces or fragments are dislodged from larger colonies to establish new colonies, although the budding of new polyps within a colony can also be considered asexual reproduction. In many species of branching corals, fragmentation is a common and sometimes dominant means of propagation.

Depending on the mode of fertilization, coral larvae (called planulae) undergo development either mostly within the mother colony (brooders) or outside of the mother colony, adrift in the ocean (broadcast spawners). In either mode of larval development, planula larvae presumably experience considerable mortality (up to 90 percent or more) from predation or other factors prior to settlement and metamorphosis. (Such mortality cannot be directly observed, but is inferred from the large amount of eggs and sperm spawned versus the much smaller number of recruits observed later.) Coral larvae are relatively poor swimmers; therefore, their dispersal distances largely depend on the duration of the pelagic phase and the speed and direction of water currents transporting the larvae. The documented maximum larval life span is 244 days (*Montastraea magnistellata*), suggesting that the potential for long-term dispersal of coral larvae, at least for some species, may be substantially greater than previously thought and may partially explain the large geographic ranges of many species.

The spatial and temporal patterns of coral recruitment have been studied extensively. Biological and physical factors that have been shown to affect spatial and temporal patterns of coral recruitment include substratum availability and community structure, grazing pressure, fecundity, mode and timing of reproduction, behavior of larvae, hurricane disturbance, physical oceanography, the structure of established coral assemblages, and chemical cues. Additionally, factors other than dispersal may influence recruitment and several other factors may influence reproductive success and reproductive isolation, including external cues, genetic precision, and conspecific signaling.

In general, on proper stimulation, coral larvae, whether brooded by parental colonies or developed in the water column, settle and metamorphose on appropriate substrates. Some evidence indicates that chemical cues from crustose coralline algae, microbial films, and/or other reef organisms or acoustic cues from reef environments stimulate settlement behaviors. Initial calcification ensues with the forming of the basal plate. Buds formed on the initial corallite develop into daughter corallites. Once larvae are able to settle onto appropriate hard substrate, metabolic energy is diverted to colony growth and maintenance. Because newly settled corals barely protrude above the substrate, juveniles need to reach a certain size to limit damage or mortality from threats such as grazing, sediment burial, and algal overgrowth. Once recruits reach about 1 to 2 years post-settlement, growth and mortality rates appear similar across species. In some species, it appears that there is virtually no limit to colony size beyond structural integrity of the colony skeleton, as polyps apparently can bud indefinitely.

4.3.4.1.2 Distribution and Abundance

Corals need hard substrate on which to settle and form; however, only a narrow range of suitable environmental conditions allows the growth of corals and other reef calcifiers to exceed loss from physical, chemical, and biological erosion. While corals do live in a fairly wide temperature range across geographic locations, accomplished via either adaptation (genetic changes) or acclimatization (physiological or phenotypic changes), reef-building corals do not thrive outside of an area characterized by a fairly narrow mean temperature range (typically 25 °C-30 °C). Two other important factors influencing suitability of habitat are light and water quality. Reef-building corals require light for photosynthetic performance of their zooxanthellae, and poor water quality can negatively affect both coral growth and recruitment. Deep distribution of corals is generally limited by availability of light. Hydrodynamic condition (*e.g.*, high wave action) is another important habitat feature, as it influences the growth, mortality, and reproductive rate of each species adapted to a specific hydrodynamic zone

4.3.4.1.3 Threats

The following section provides an overview of threats to coral species.

4.3.4.1.3.1 Ocean Warming

Ocean warming is one of the most important threats posing extinction risks to the 82 candidate coral species; however, individual susceptibility varies among species. The primary observable coral response to ocean warming is bleaching of adult coral colonies, wherein corals expel their symbiotic zooxanthellae in response to stress. For corals, an episodic increase of only 1°C-2°C above the normal local seasonal maximum ocean temperature can induce bleaching. Corals can withstand mild to moderate bleaching; however, severe, repeated, or prolonged bleaching can lead to colony death. While coral bleaching patterns are complex, with several species exhibiting seasonal cycles in symbiotic dinoflagellate density, thermal stress has led to bleaching and associated mass mortality in many coral species during the past 25 years. In addition to coral bleaching, other effects of ocean warming detrimentally affect virtually every life-history stage in reef-building corals. Impaired fertilization, developmental abnormalities, mortality, impaired settlement success, and impaired calcification of early life phases have all been documented.

Spatially, exposure of colonies of a species to ocean warming can vary greatly across its range, depending on colony location (*e.g.*,latitude, depth, bathymetry, habitat type, etc.) and physical processes that affect seawater temperature and its effects on coral colonies (*e.g.,* winds, currents, upwelling shading, tides, etc.). Colony location can moderate exposure of colonies of the species to ocean warming by latitude or depth, because colonies in higher latitudes and/or deeper areas are usually less affected by warming events. Also, some locations are blocked from warm currents by bathymetric features, and some habitat types reduce the effects of warm water, such as highly-fluctuating environments. Physical processes can moderate exposure of colonies of the species to ocean warming in many ways, including processes that increase mixing (*e.g.,* wind, currents, tides),reduce seawater temperature (*e.g.,* upwelling, runoff), or increase shading (*e.g.* turbidity, cloud cover). For example, warming events in Hawaii in 1996 and 2002 resulted in variable levels of coral bleaching because colony exposure was strongly affected by winds, cloud cover, complex bathymetry, waves, and inshore currents (NMFS 2012b, SIR Section 3.2.2).

Temporally, exposure of colonies of a species to ocean warming between now and 2100 will likely vary annually and decadally, while increasing over time, because: (1) Numerous annual and decadal processes that affect seawater temperatures will continue to occur in the future (*e.g.,* inter-decadal variability in seawater temperatures and upwelling related to El-Niño Southern Oscillation); and (2) ocean warming is predicted to substantially worsen by 2100. While exposure of the 82 candidate coral species to ocean warming varies greatly both spatially and temporally, exposure is expected to increase for all species across their ranges between now and 2100 (NMFS 2012b, SIR Section 3.2.2).

Multiple threats stress corals simultaneously or sequentially, whether the effects are cumulative (the sum of individual stresses) or interactive (*e.g.,* synergistic or antagonistic). Ocean warming is likely to interact with many other threats, especially considering the long-term consequences of repeated thermal stress, and ocean warming is expected to continue to worsen over the reasonably foreseeable future. Increased seawater temperature interacts with coral diseases to reduce coral health and survivorship. Coral disease outbreaks often have either accompanied or immediately followed bleaching events, and also follow seasonal patterns of high seawater temperatures. The effects of greater ocean warming (*i.e.*, increased bleaching, which kills or weakens colonies) are expected to interact with the effects of higher storm intensity (*i.e.*, increased breakage of dead or weakened colonies) in the Caribbean, resulting in an increased rate of coral declines. Likewise, ocean acidification and nutrients may reduce thermal thresholds to bleaching, increase mortality and slowing recovery.

There is also mounting evidence that warming ocean temperatures can have direct impacts on early life stages of corals, including abnormal embryonic development at 32°C and complete fertilization failure at 34°C for one Indo-Pacific *Acropora* species. In addition to abnormal embryonic development, symbiosis establishment, larval survivorship, and settlement success have been shown to be impaired in Caribbean brooding and broadcasting coral species at temperatures as low as 30°C-32°C. Further, the rate of larval development for spawning species is appreciably accelerated at warmer temperatures, which suggests that total dispersal distances could also be reduced, potentially decreasing the likelihood of successful settlement and the potential for replenishment of extirpated areas.

Finally, warming is and will continue causing increased stratification of the upper ocean, because water density decreases with increasing temperature. Increased stratification results in decreased vertical mixing of both heat and nutrients, leaving surface waters warmer and nutrient-poor. While the implications for corals and coral reefs of these increases in warming-induced stratification have not been well studied, it is likely that these changes will both exacerbate the temperature effects described above (*i.e.*, increase bleaching and decrease recovery) and decrease the overall net productivity of coral reef ecosystems (*i.e.*, fewer nutrients) throughout the tropics and subtropics.

Overall, there is ample evidence that climate change (including that which is already committed to occur from past GHG emissions and that which is reasonably certain to result from continuing and future emissions) will follow a trajectory that will have a major impact on corals. If many coral species are to survive anticipated global warming, corals and their zooxanthellae will have to undergo significant acclimatization and/or adaptation. There has been a recent research emphasis on the processes of acclimatization and adaptation in corals, but, taken together, the body of research is inconclusive on how these processes may affect individual corals' extinction risk, given the projected intensity and rate of ocean warming (NMFS 2012b, SIR Section 3.2.2.1). In determining extinction risk for the 82 candidate coral species, the review team was most strongly influenced by observations that corals have been bleaching and dying under ocean warming that has already occurred. Thus, the review team determined that ocean warming and related impacts of global climate change are already having serious negative impacts on many corals, and that ocean warming is one of the most important threats posing extinction risks to the 82 candidate coral species between now and the year 2100 (Brainard et al. 2011).

4.3.4.1.3.2 Disease

Coral diseases are a common and significant threat affecting most or all coral species and regions to some degree, although the scientific understanding of individual disease causes in corals remains very poor. The incidence of coral disease appears to be expanding geographically in the Indo-Pacific and there is evidence that massive coral species are not recovering from disease events in certain locations. The prevalence of disease is highly variable between sites and species. There is documented increased prevalence and severity of diseases with increased water temperatures, which may correspond to increased virulence of pathogens, decreased resistance of hosts, or both. Moreover, the expanding coral disease threat has been suggested to result from opportunistic pathogens that become damaging only in situations where the host integrity is compromised by physiological stress and/or immune suppression. Overall, there is mounting evidence that warming temperatures and coral bleaching responses are linked (albeit with mixed correlations) with increased coral disease prevalence and mortality. Complex aspects of temperature regimes, including winter and summer extremes, may influence disease outbreaks. Bleaching and coral abundance seem to increase the susceptibility of corals to disease contraction. Further, most recent research shows strong correlations between elevated human population density in close proximity to reefs and disease prevalence in corals.

Although disease causes in corals remain poorly understood, some general patterns of biological susceptibility are beginning to emerge. There appear to be predictable patterns of immune capacity across coral families, corresponding with trade-offs with their life history traits, such as reproductive output and growth rate. *Acroporidae*, representing the largest number of candidate species, has low immunity to disease. Likewise, *Pocilloporidae* has low immunity; however, both of these families have intermediate/high reproductive outputs.

Both *Faviidae* and *Mussidae* are intermediate to high in terms of disease immunity and reproductive output. Finally, while *Poritidae* has high immunity to disease, it has a low reproductive output. Overall, disease represents a high importance threat in terms of extinction risk posed to coral species; however, individual susceptibility varies among the 82 candidate species.

As with ocean warming, the effects of coral disease depend on exposure of the species to the threat, which can vary spatially across the range of the species, and temporally between now and 2100. Spatially, exposure to coral disease in the Caribbean is moderated by distance of some coral habitats from the primary causes of most disease outbreaks, such as stressors resulting from sedimentation, nutrient over-enrichment, and other local threats. Exposure to coral disease for some species in the Indo-Pacific may be somewhat more moderated spatially than in the Caribbean, due to a greater proportion of reef-building coral habitats located in remote areas that are much farther away from local sources of disease outbreaks. Exposure to coral disease can also be moderated by depth of many habitats in both regions, but again more so in the Indo-Pacific than in the Caribbean. Deep habitats are generally less affected by disease outbreaks associated with stressors resulting from ocean warming, especially in the Indo-Pacific. Disease exposure in remote areas and deep habitats appears to be low but gradually increasing. Temporally, exposure to coral disease will increase as the causes of disease outbreaks (*e.g.,* warming events) increase over time (NMFS, 2012b, SIR Section 3.3.2).

As explained above, disease may be caused by a threat such as ocean warming and bleaching, nutrients, toxins, etc. However, interactive effects are also important for this threat, because diseased colonies are more susceptible to the effects of some other threats. For example, diseased or recovering colonies may be more quickly stressed than healthy colonies by land-based sources of pollution (sedimentation, nutrients, and toxins), more quickly succumb to predators, and more easily break during storms or as a result of other physical impacts. There are likely many other examples of cumulative and interactive effects of disease with other threats to corals.

4.3.4.1.3.3 Ocean Acidification

As with ocean warming, ocean acidification is a result of global climate change caused by increased GHG accumulation in the atmosphere. Reef-building corals produce skeletons made of the aragonite form of calcium carbonate; thus, reductions in aragonite saturation state caused by ocean acidification pose a major threat to these species and other marine calcifiers. Ocean acidification has the potential to cause substantial reduction in coral calcification and reef cementation. Further, ocean acidification adversely affects adult growth rates and fecundity, fertilization, pelagic planula settlement, polyp development, and juvenile growth. The impacts of ocean acidification can lead to increased colony breakage and fragmentation and mortality. Based on observations in areas with naturally low pH, the effects of increasing ocean acidification may also include potential reductions in coral size, cover, diversity, and structural complexity.

As CO_2 concentrations increase in the atmosphere, more CO_2 is absorbed by the oceans, causing lower pH and reduced availability of carbonate ions, which in turn results in lower aragonite saturation state in seawater. Because of the increase in CO_2 and other GHGs in the atmosphere since the Industrial Revolution, ocean acidification has already occurred throughout the world's oceans, including in the Caribbean and Indo-Pacific, and is predicted to considerably worsen between now and 2100. Along with ocean warming and disease, the BRT considered ocean acidification to be one of the most important threats posing extinction risks to coral species between now and the year 2100; however, individual susceptibility varies among the 82 candidate species.

Numerous laboratory and field experiments have shown a relationship between elevated CO_2 and decreased calcification rates in particular corals and other calcium carbonate secreting organisms. However, because only a few species have been tested for such effects, it is uncertain how most will fare in increasingly acidified oceans. In addition to laboratory studies, recent field studies have demonstrated a decline in linear growth rates of some coral species, suggesting that ocean acidification is already significantly reducing growth of corals on reefs. However, this has not been shown for all corals at all reefs, indicating that all corals may not be affected at the same rate or that local factors may be ameliorating the saturation states on reefs. A potential secondary effect is that ocean acidification may reduce the threshold at which bleaching occurs. Overall, the best available information demonstrates that most corals exhibit declining calcification rates with rising CO_2 concentrations, declining pH, and declining carbonate saturation state—although the rate and mode of decline can vary among species. Recent publications also discuss the physiological effects of ocean acidification on corals and their responses. Corals are able to regulate pH within their tissues, maintaining higher pH values in their tissues than the pH of surrounding waters. This is an important mechanism in naturally highly fluctuating environments (*e.g.*, many backreef pools have diurnally fluctuating pH) and suggests that corals have some adaptive capacity to acidification. However, as with ocean warming, there is high uncertainty as to whether corals will be able to adapt commensurate with the rate of acidification.

In addition to the direct effects on coral calcification and growth, ocean acidification may also affect coral recruitment, reef cementation, and other important reef-building species like crustose coralline algae (CCA). Studies suggest that the low pH associated with ocean acidification may impact coral larvae in several ways, including reduced survival and recruitment. Ocean acidification may influence settlement of coral larvae on coral reefs more by indirect alterations of the benthic community, which provides settlement cues, than by direct physiological disruption. A major potential impact from ocean acidification is a reduction in the structural stability of corals and reefs, which results both from increases in bioerosion and decreases in reef cementation. As atmospheric CO_2 rises globally, reef-building corals areexpected to calcify more slowly and become more fragile. Increased bioerosion of coral reefs from ocean acidification may be facilitated by declining growth rates of CCA. Recent studies demonstrate that ocean acidification is likely having a great impact on corals and reef communities by affecting community composition and dynamics, exacerbating the effects of disease and other stressors (*e.g.,* temperature), contributing to habitat loss, and affecting symbiotic function. Some studies have found that an atmospheric CO_2 level twice as high as pre-industrial levels will start to dissolve coral reefs; this level could be reached as early as the middle of this century. Further, the rate of acidification may be an order of magnitude faster than what occurred 55 million years ago during the Paleocene-Eocene Thermal Maximum (Brainard et al. 2011) (NMFS, 2012b, SIR Section 3.2.3).

Spatially, while CO_2 levels in the surface waters of the ocean are generally in equilibrium with the lower atmosphere, there can be considerable variability in seawater pH across reef-building coral habitats, resulting in colonies of a species experiencing high spatial variability in exposure to ocean acidification. The spatial variability in seawater pH occurs from reef to global scales, driven by numerous physical and biological characteristics and processes, including at least seawater temperature, proximity to land-based runoff and seeps, proximity to sources of oceanic CO_2, salinity, nutrients, photosynthesis, and respiration. CO_2 absorption is higher in colder water, causing lower pH in colder water. Land-based runoff decreases salinity and increases nutrients, both of which can raise pH. Local sources of oceanic CO_2 like upwelling and volcanic seeps lower pH. Photosynthesis in algae and seagrass beds draws down CO_2, raising pH. These are just some of the sources of spatial variability in pH, which results in high spatial variability in ocean acidification across the ranges of the 82 species (NMFS, 2012b, SIR Section 3.2.3).

Temporally, high variability over diurnal to decadal time-scales is produced by numerous processes, including diurnal cycles of photosynthesis and respiration, seasonal variability in seawater temperatures, and decadal cycles in upwelling. Temporal variability in pH can be very high diurnally in highly-fluctuating or semi-enclosed habitats such as reef flats and back-reef pools, due to high photosynthesis during the day (pH goes up) and high respiration during the night (pH goes down). In fact, pH fluctuations during one 24-hr period in such reef-building coral habitats can exceed the magnitude of change expected by 2100 in open ocean subtropical and tropical waters. As with spatial variability in exposure to ocean warming, temporal variability in exposure to ocean acidification is a combination of high variability over short time-scales together with long-term increases. While exposure of the 82 candidate coral species to ocean acidification varies greatly both spatially and temporally, exposure is expected to increase for all species across their ranges between now and 2100 (NMFS, 2012b, SIR Section 3.2.3).

Acidification is likely to interact with other threats, especially considering that acidification is expected to continue to worsen over the reasonably foreseeable future. For example, acidification may reduce the threshold at which bleaching occurs, increasing the threat posed by ocean warming. One of the key impacts of acidification is reduced calcification, resulting in reduced skeletal growth and skeletal density, which may lead to numerous interactive effects with other threats. Reduced skeletal growth compromises the ability of coral colonies to compete for space against algae, which grows more quickly as nutrient over-enrichment increases. Reduced skeletal density weakens coral skeletons, resulting in greater colony breakage from natural and human-induced physical damage.

4.3.4.1.3.4 Trophic Effects of Fishing
Fishing, particularly overfishing, can have large scale, long-term ecosystem-level effects that can change ecosystem structure from coral-dominated reefs to algal-dominated reefs ("phase shifts"). Fishing pressure alters trophic interactions that are particularly important in structuring coral reef ecosystems. These trophic interactions include reducing population abundance of herbivorous fish species that control algal growth, limiting the size structure of fish populations, reducing species richness of herbivorous fish, and releasing corallivores from predator control. Thus, an important aspect of maintaining resilience in coral reef ecosystems is to sustain populations of herbivores, especially the larger scarine herbivorous wrasses such as parrotfish.

On topographically complex reefs, population densities can average well over a million herbivorous fishes per km [2] , and standing stocks can reach 45 metric tons per km [2] . In the Caribbean, parrotfishes can graze at rates of more than 150,000 bites per square meter per day, and thereby remove up to 90-100 percent of the daily primary production (*e.g.,* algae). Under these conditions of topographic complexity with substantial populations of herbivorous fishes, as long as the cover of living coral is high and resistant to mortality from environmental changes, it is very unlikely that the algae will take over and dominate the substratum. However, if herbivorous fish populations, particularly large-bodied parrotfish, are heavily fished and a major mortality of coral colonies occurs, then algae can grow rapidly and prevent the recovery of the coral population. The ecosystem can then collapse into an alternative stable state, a persistent phase shift in which algae replace corals as the dominant reef species. Although algae can have negative effects on adult coral colonies (*i.e.,* overgrowth, bleaching from toxic compounds), the ecosystem-level effects of algae are primarily from inhibited coral recruitment. Filamentous algae can prevent the colonization of the substratum by planula larvae by creating sediment traps that obstruct access to a hard substratum for attachment. Additionally, macroalgae can suppress the successful colonization of the substratum by corals through occupation of the available space, shading, abrasion, chemical poisoning, and infection with bacterial disease.

Overfishing can have further impacts on coral mortality via trophic cascades. In general larger fish are targeted, resulting in fish populations of small individuals. For parrotfishes, the effect of grazing by individuals greater than 20 cm in length is substantially greater than that of smaller fish. Up to 75 individual parrotfishes with lengths of about 15 cm are necessary to have the same effect on reducing algae and promoting coral recruitment as a single individual 35 cm in length. Species richness of the herbivorous fish population is also necessary to enhance coral populations. Because of differences in their feeding behaviors, several species of herbivorous fishes with complementary feeding behaviors can have a substantially greater positive effect than a similar biomass of a single species on reducing the standing stock of macroalgae, of increasing the cover of CCA, and increasing live coral cover.

Spatially, exposure to the trophic effects of fishing in the Caribbean ismoderated by distance of some coral habitats from fishing effort. Exposure to the trophic effects of fishing in the Indo-Pacific is somewhat more moderated by distance than in the Caribbean, due to a greater proportion of reef-building coral habitats located in remote areas that are much farther away from fishing effort. Exposure to the trophic effects of reef fishing is also moderated by depth of many habitats in both regions, but again more so in the Indo-Pacific than in the Caribbean. Deep habitats are generally less affected by the trophic effects of fishing especially in the Indo-Pacific. Temporally, exposure to the trophic effects of fishing will increase as the human population increases over time (NMFS, 2012b, SIR Section 3.3.4).

The trophic effects of fishing are likely to interact with many other threats, especially considering that fishing impacts are likely to increase within the ranges of many of the 82 species over the reasonably foreseeable future. For example, when carnivorous fishes are overfished, corallivore populations may increase, resulting in greater predation on corals. Further, overfishing appears to increase the frequency of coral disease. Fishing activity usually targets the larger apex predators. When the predators are removed, corallivorous butterfly fishes become more abundant and can transmit disease from one coral colony to another as they transit and consume from each coral colony. With increasing abundance, they transmit disease to higher proportions of the corals within the population.

4.3.4.1.3.5 Sedimentation

Impacts from land-based sources of pollution include sedimentation, nutrients, toxicity, contaminants, and changes in salinity regimes. The BRT evaluated the extinction risk posed by each pollution component individually. Only the stressors of sedimentation and nutrients were considered low-medium threats to corals, although the 82 candidate species vary in susceptibility. The BRT considered contaminants, despite their primarily local sources and impacts, to pose low, but not negligible, extinction risks, and salinity effects to be a local and negligible overall contributor to extinction risk to the 82 candidate coral species; however, individual species vary in susceptibility. All four threats associated with land-based sources of pollution are described in the SRR, and sedimentation and nutrients are considered separately below. Human activities in coastal watersheds introduce sediment into the ocean by a variety of mechanisms, including river discharge, surface runoff, groundwater seeps, and atmospheric deposition. Humans introduce sewage into coastal waters through direct discharge, treatment plants, and septic leakage; agricultural runoff brings additional nutrients from fertilizers.

Elevated sediment levels are generated by poor land use practices, and coastal and nearshore construction. Additionally, as coastal populations continue to increase, it is likely that pollution from land-based sources will also increase.

The most common direct effect of sedimentation is deposition of sediment on coral surfaces as sediment settles out from the water column. Corals with certain morphologies (*e.g.*, mounding) can passively reject settling sediments. In addition, corals can actively displace sediment by ciliary action or mucous production, both of which require energetic expenditures. Corals with large calices (skeletal component that holds the polyp) tend to be better at actively rejecting sediment. Some coral species can tolerate complete burial for several days. Corals that are unsuccessful in removing sediment will be smothered and die. Sediment can also induce sublethal effects, such as reductions in tissue thickness, polyp swelling, zooxanthellae loss, and excess mucus production. In addition, suspended sediment can reduce the amount of light in the water column, making less energy available for coral photosynthesis and growth. Finally, sediment impedes fertilization of spawned gametes and reduces larval settlement, as well as the survival of recruits and juveniles.

Although it is difficult to quantitatively predict the extinction risk that sedimentation poses to the 82 candidate coral species, human activity has resulted in quantifiable increases in sediment inputs in some reef areas. Continued increases in coastal populations combined with poor land use and nearshore development practices will likely increase sediment delivery to reef systems. Nearshore sediment levels will also likely increase with sea level rise. Greater inundation of reef flats can erode soil at the shoreline and resuspend lagoon deposits, producing greater sediment transport and potentially leading to leeward reefs being flooded with turbid lagoon waters or buried by off-bank sediment transport. Finally, while some corals may be more tolerant of elevated short-term levels of sedimentation, sediment stress and turbidity can induce bleaching. Sedimentation is a low-medium importance threat of extinction risk to corals; however, individual susceptibility varies among the 82 candidate species.

The BRT acknowledged that individual land-based sources of pollution interact in complex ways, and therefore also considered the holistic nature of this type of threat (*i.e.*, sedimentation, nutrient over-enrichment, and contaminants). All land-based sources of pollution act primarily at a local level and have direct linkage to human population, consumption of resources, and land use within the local area. This linkage is supported by correlative and retrospective studies of both threat dosage of and coral response to land-based sources of pollution. Therefore, land-based sources of pollution would pose a substantial extinction risk only to species with extremely limited distributions. However, local stresses can still be sufficiently severe to cause local extirpation and interact with global stresses to increase extinction risk.

Spatially, exposure to sedimentation in the Caribbean can be moderated by distance of some coral habitats from areas where sedimentation is chronically or sporadically heavy (*i.e.*, heavily populated areas), resulting in some areas of coral habitats being unaffected or very lightly affected by sedimentation. Exposure to sedimentation can be more moderated in the Indo-Pacific by the large distances of many coral habitats from areas where sedimentation is chronically or sporadically heavy (*i.e.*, heavily populated areas), resulting in vast areas of coral habitats and areas being unaffected or very lightly affected by sedimentation. Exposure to sedimentation for particular species could also be moderated by depth of many habitats in both regions, but again more so in the Indo-Pacific than in the Caribbean. Deep habitats are generally less affected by sedimentation, especially in the Indo-Pacific. Temporally, exposure to sedimentation will increase as human activities that produce sedimentation increase over time, but in the Indo-Pacific will still be strongly moderated for certain species by distance (NMFS, 2012b, SIR Section 3.3.1).

Sedimentation is also likely to interact with many other threats, especially considering that sedimentation is likely to increase across the ranges of many of the 82 species over the reasonably foreseeable future. For example, when coral communities that are chronically affected by sedimentation experience a warming-induced bleaching event and associated disease outbreaks, the consequences for corals can be much more severe than in communities not affected by sedimentation.

4.3.4.1.3.6 Nutrients

The impacts of nutrient over-enrichment were determined by the BRT to be of low-medium importance in terms of posing extinction risk to coral species; however, individual susceptibility varies among the 82 candidate species. Elevated nutrients affect corals through two main mechanisms—direct impacts on coral physiology and indirect effects through nutrient-stimulation of other community components (*e.g.,* macroalgal turfs and seaweeds, and filter feeders) that compete with corals for space on the reef. Increased nutrients can decrease calicification; however, nutrients may also enhance linear extension, but reduce skeletal density. Either condition results in corals that are more prone to breakage or erosion. Notably, individual species have varying tolerance to increased nutrients. The main vectors of anthropogenic nutrients are point-source discharges (such as rivers or sewage outfalls) and surface runoff from modified watersheds. Natural processes, such as in situ nitrogen fixation and delivery of nutrient-rich deep water by internal waves and upwelling, bring nutrients to coral reefs as well. Nutrient over-enrichment has low-medium importance to the extinction risk of all 82 corals species.

Spatially, exposure to nutrients is moderated by distance of some coral habitats from areas where nutrients are chronically or sporadically heavy (*i.e.,* heavily populated areas). However, nutrient over-enrichment can result from very small human populations, and nutrients can be quickly transported large distances; thus, distance is less of a moderating factor for nutrients than for sedimentation. Similarly, although nutrient exposure may also be moderated by depth of some habitats, nutrient impacts can reach much farther than sedimentation impacts. Temporally, exposure to nutrients will increase as human activities that produce nutrients increase over time (NMFS, 2012b, SIR Section 3.3.1).

Nutrients are likely to interact with many other threats, especially considering that nutrient over-enrichment is likely to increase across the ranges of many of the 82 candidate species over the reasonably foreseeable future. For example, when coral communities that are chronically affected by nutrients experience a warming-induced bleaching event and associated disease outbreaks, the consequences for corals can be much more severe than in communities not affected by nutrients.

4.3.4.1.3.7 Sea Level Rise

The effects of sea-level rise may affect various coral life history events, including larval settlement, polyp development, and juvenile growth, and contribute to adult mortality and colony fragmentation, mostly due to increased sedimentation and decreased water quality (reduced light availability) caused by coastal inundation. The best available information suggests that sea level will continue to rise due to thermal expansion and the melting of land and sea ice. Theoretically, any rise in sea-level could potentially provide additional habitat for corals living near the sea surface. Many corals that inhabit the relatively narrow zone near the ocean surface have rapid growth rates when healthy, which allowed them to keep up with sea-level rise during the past periods of rapid climate change associated with deglaciation and warming. However, depending on the rate and amount of sea level rise, rapid rises can lead to reef drowning. Rapid rises in sea level could affect many of the candidate coral species by both submerging them below their common depth range and, more likely, by degrading water quality through coastal erosion and potentially severe sedimentation or enlargement of lagoons and shelf areas. Rising sea level is likely to cause mixed responses in the 82 candidate coral species depending on their depth preferences, sedimentation tolerances, growth rates, and the nearshore topography. Reductions in growth rate due to local stressors, bleaching, infectious disease, and ocean acidification may prevent the species from keeping up with sea level rise (*e.g.*, from growing at a rate that will allow them to continue to occupy their preferred depth range despite sea-level rise).

The rate and amount of future sea level rise remains uncertain. Until the past few years, sea level rise was predicted to be in the range of only about one half meter by 2100. However, more recent estimated rates are higher, based upon evidence that the Greenland and Antarctic ice sheets are much more vulnerable than previously thought. Hence, there is large variability in predictions of the sea-level rise, but the IPCC Fourth Assessment Report likely underestimated the rates.

Fast-growing branching corals were able to keep up with the first 3 m of sea level rise during the warming that led to the last interglacial period. However, whether the 82 candidate coral species will be able to survive 3 m or more of future sea level rise will depend on whether growth rates are reduced as a result of other risk factors, such as local environmental stressors, bleaching, infectious disease, and ocean acidification. Additionally, lack of suitable new habitat, limited success in sexual recruitment, coastal runoff, and coastal hardening will compound some corals' ability to survive rapid sea level rise.

This threat is expected to disproportionately affect shallow areas adjacent to degraded coastlines, as inundation results in higher levels of sedimentation from the newly-inundated coastlines to the shallow areas. Spatially, exposure to sea-level rise will be moderated by horizontal and vertical distances of reef-building coral habitats from inundated, degraded coastlines. Temporally, exposure to sea-level rise will increase over time as the rate of rise increases (NMFS, 2012b, SIR Section 3.2.4).

Sea-level rise is likely to interact with other threats, especially considering that sea-level rise is likely to increase across the ranges of the 82 candidate species over the reasonably foreseeable future. For example, the inundation of developed areas (*e.g.,* urban and agricultural areas) and other areas where shoreline sediments are easily eroded by sea-level rise is likely to degrade water quality of adjacent coral habitat, through increased sediment and nutrient runoff, and the potential release of toxic contamination.

4.3.4.1.3.8 Predation

Numerous studies have documented the quantitative impact of predation by various taxa on coral tissue and skeleton. Predators can indirectly affect the distribution of corals by preferentially consuming faster-growing coral species, thus allowing slower-growing corals to compete for space on the reef. The most notable example of predation impacts in the Indo-Pacific are from large aggregations of crown-of-thorns seastar (*Acanthaster planci;*COTS), termed outbreaks; the specific causative mechanism of COTS outbreaks is unknown. COTS can reduce living coral cover to less than one percent during outbreaks, change coral community structure, promote algal colonization, and affect fish population dynamics. Therefore, predation, although considered to be of low importance to the extinction risk of corals in general, can be significant to individual species.

Spatially, exposure to predation by corallivores is moderated by presence of predators of the corallivores (*i.e.,* predators of the predators). For example, corallivorous reef fish prey on corals, and piscivorous reef fish and sharks prey on the corallivores; thus, high abundances of piscivorous reef fish and sharks moderates coral predation. Abundances of piscivorous reef fish and sharks vary spatially because of different ecological conditions and human exploitation levels. Spatially, exposure to predation is also moderated by distance from physical conditions that allow corallivore populations to grow. For example, in the Indo-Pacific, high nutrient runoff from continents and high islands improves reproductive conditions for COTS, thus coral predation by COTS is moderated by distance from such conditions. Predation can also be moderated by depth of many habitats because abundances of many corallivorous species decline with depth. Temporally, exposure to predation will increase over time as conditions change, but will still be strongly moderated by distance and depth for certain species, depending upon the distribution and abundances of a species' populations, relative to this threat (NMFS, 2012b, SIR Section 3.3.3).

Predation of coral colonies can increase the likelihood of the colonies being infected by disease, and likewise diseased colonies may be more likely to be preyed upon. There are likely other examples of cumulative and interactive effects of predation with other threats to corals.

4.3.4.1.3.9 Collection and Trade

Globally, 1.5 million live stony coral colonies are reported to be collected from at least 45 countries each year, with the United States consuming the largest portion of live corals (64 percent) and live rock (95 percent) for the aquarium trade. The imports of live corals taken directly from coral reefs (not from aquaculture) increased by 600 percent between 1988 and 2007, while the global trade in live coral increased by nearly 1,500 percent. Harvest of stony corals is usually highly destructive, and results in removing and discarding large amounts of live coral that go unsold and damaging reef habitats around live corals. While collection is a highly spatially focused impact, it can result in significant impacts and was considered to contribute to individual species' extinction risk.

Spatially, exposure to collection and trade is moderated by demand, and can be moderated by distance and depth. Demand is highly species-specific, resulting in variable levels of collection pressure. However, even for heavily-collected species, geographic and depth distributions strongly moderate collection because distance from land and depth create barriers to human access. Temporally, exposure to collection and trade may increase over time, but will still continue to be strongly moderated by demand, distance, and depth (NMFS, 2012b, SIR Section 3.3.6).

Collection and trade of coral colonies can increase the likelihood of the colonies being infected by disease, due to both the directed and incidental breakage of colonies, which are then more easily infected. There are likely other examples of cumulative and interactive effects of collection and trade with other threats to corals.

4.3.4.2 ***Potential Effects of Acoustic Stressors on Corals***

The U.S. Navy's analysis highlighted that very little is known about sound detection and use of sound by aquatic invertebrates {Budelmann, 1992 #155899;Budelmann, 1992 #155900}(Popper 2001){Montgomery, 2006 #155891}. Organisms may detect sound by sensing either the particle motion or pressure component of sound, or both. Aquatic invertebrates probably do not detect pressure since many are generally the same density as water and few, if any, have air cavities that would function like the fish swim bladder in responding to pressure {Budelmann, 1992 #155900}(Popper 2001). Many aquatic invertebrates, however, have ciliated "hair" cells that may be sensitive to water movements, such as those caused by currents or water particle motion very close to a sound source {Budelmann, 1992 #155899;Budelmann, 1992 #155900}{Mackie, 2003 #155897}. This may allow sensing of nearby prey or predators or help with local navigation.

Aquatic invertebrates that can sense local water movements with ciliated cells include cnidarians, flatworms, segmented worms, urochordates (tunicates), mollusks, and arthropods {Budelmann, 1992 #155899;Budelmann, 1992 #155900}(Popper 2001). The sensory capabilities of corals are largely limited to detecting water movement using receptors on their tentacles {Gochfeld, 2004 #155896}, and the exterior cilia of coral larvae likely help them detect nearby water movements (Vermeij et al. 2010). Some aquatic invertebrates have specialized organs called statocysts for determination of equilibrium and, in some cases, linear or angular acceleration. Statocysts allow an animal to sense movement and may enable some species, such as cephalopods and crustaceans, to be sensitive to water particle movements associated with sound (Hu et al. 2009){Montgomery, 2006 #155891}{Kaifu, 2008 #155892}(Popper 2001). Because any acoustic sensory capabilities, if present at all, are limited to detecting water motion, and water particle motion near a sound source falls off rapidly with distance, aquatic invertebrates are probably limited to detecting nearby sound sources rather than sound caused by pressure waves from distant sources.

Both behavioral and auditory brainstem response studies suggest that crustaceans may sense sounds up to 3 kilohertz (kHz), but best sensitivity is likely below 200 Hertz (Hz) {Lovell, 2005 #155893;Lovell, 2006 #155894}(Goodall et al. 1990). Most cephalopods (e.g., octopus and squid) likely sense low-frequency sound below 1,000 Hz, with best sensitivities at lower frequencies {Budelmann, 1992 #155900}{Mooney, 2010 #155890}(Packard and Packard 1990). A few may sense higher frequencies up to 1,500 Hz (Hu et al. 2009). Squid did not respond to toothed whale ultrasonic echolocation clicks at sound pressure levels ranging from 199 to 226 decibels (dB) referenced to (re) 1 μ (micro) Pascal (Pa) peak-to-peak, likely because these clicks were outside of squid hearing range (Wilson et al. 2007). However, squid exhibited alarm responses when exposed to broadband sound from an approaching seismic airgun with received levels exceeding 145 to 150 dB re 1 μPa2-second (- s) root mean square (McCauley et al. 2000a).

Aquatic invertebrates may produce and use sound in territorial behavior, to deter predators, to find a mate, and to pursue courtship (Popper 2001). Some crustaceans produce sound by rubbing or closing hard body parts together, such as lobsters and snapping shrimp (Au and Banks 1998){Patek, 2006 #155880}{Latha, 2005 #155881}. The snapping shrimp chorus makes up a significant portion of the ambient noise in many locales (Au and Banks 1998){Cato, 1992 #155882}. Each click is up to 215 dB re 1 μPa, with a peak around 2 to 5 kHz (Au and Banks 1998){Heberholz, 2001 #155883}. Other crustaceans make low-frequency rasping or rumbling noises, perhaps used in defense or territorial display, that are often obscured by ambient noise {Patek, 2006 #155880}{Patek, 2009 #155885}.

Reef noises, such as fish pops and grunts, sea urchin grazing (around 1.0 kHz to 1.2 kHz), and snapping shrimp noises (around 5 kHz) (Radford et al. 2010), may be used as cues by some aquatic invertebrates. Nearby reef noises were observed to affect movements and settlement behavior of coral and crab larvae (Vermeij et al. 2010){Jeffs, 2003 #155884}{Radford, 2007 #155886}{Stanley, 2001 #155888}. Larvae of other crustacean species, including pelagic and nocturnally emergent species that benefit from avoiding predators associated with coral reefs, appear to avoid reef noises {Simpson, 2011 #155887}. Detection of reef noises is likely limited to short distances (less than 330 ft. [100 m]) (Vermeij et al. 2010).

Because research on the consequences of exposing marine invertebrates to anthropogenic sounds is limited, qualitative analyses were conducted to determine the effects of the following acoustic stressors on marine invertebrates within the Study Area: non-impulsive sources (including sonar, vessel noise, aircraft overflights, and other active acoustic sources) and impulsive acoustic sources (including explosives, airguns, and weapons firing).

Most marine invertebrates cannot sense mid- or high-frequency sounds, distant sounds, or aircraft noise transmitted through the air-water interface. Most marine invertebrates would not be close enough to intense sound sources, such as some sonars, to potentially experience impacts to sensory structures. Any marine invertebrate capable of sensing sound may alter its behavior if exposed to non-impulsive sound, although it is unknown if responses to non-impulsive sounds occur. Continuous noise, such as from vessels, may contribute to masking of relevant environmental sounds, such as reef noise. Because the distance over which most marine invertebrates are expected to detect any sounds is limited and vessels would be in transit, any sound exposures with the potential to cause masking or behavioral responses would be brief. Without prolonged proximate exposures, long-term impacts are not expected. Although non-impulsive underwater sounds produced during training activities may briefly impact some individuals capable of detecting sounds, intermittent exposures to non-impulsive sounds are not expected to impact survival, growth, recruitment, or reproduction of widespread marine invertebrate populations.

4.3.4.3 *Potential Effects of Energy Stressors on Corals*

The U.S. Navy analyzed the potential impacts of the various types of energy stressors associated with training and testing activities within the Study Area. Specifically, they assessed the potential impacts from (1) electromagnetic devices, and (2) high energy lasers.

4.3.4.3.1 Electromagnetic Devices

The U.S. Navy analysis acknowledges that little information exists regarding susceptibility of corals to electromagnetic fields. Most corals are thought to use water temperature, day length, and tidal fluctuations as cues for spawning. Magnetic fields are not known to control coral spawning release or larval settlement. Some arthropods (e.g., spiny lobster and American lobster) can sense magnetic fields, and this is thought to assist the animal with navigation and orientation (Lohmann et al. 1995){Normandeau, 2011 #155867}. These animals travel relatively long distances during their lives, and it is possible that magnetic field sensation exists for other invertebrates that travel long distances. Marine invertebrates, including several commercially important species and federally managed species, have the potential to use magnetic cues {Normandeau, 2011 #155867}. Susceptibility experiments have focused on arthropods, but several mollusks and echinoderms are also susceptible. However, because susceptibility is variable within taxonomic groups it is not possible to make generalized predictions for groups of marine invertebrates. Sensitivity thresholds vary by species ranging from 0.3–30 milliTesla (mT), and responses included non-lethal physiological and behavioral changes {Normandeau, 2011 #155867}. The primary use of magnetic cues seems to be navigation and orientation. Human-introduced electromagnetic fields have the potential to disrupt these cues and interfere with navigation, orientation, and migration. Because electromagnetic fields weaken exponentially with distance from the source, large and sustained magnetic fields present greater exposure risks than small and transient fields, even if the small field is many times stronger than the earth’s magnetic field {Normandeau, 2011 #155867}. Transient or moving electromagnetic fields may cause temporary disturbance to susceptible organisms’ navigation and orientation.

There is no overlap of electromagnetic device use with designated critical habitat for elkhorn and staghorn coral. Therefore, stressors from electromagnetic devices would not be present in elkhorn and staghorn coral critical habitat.

4.3.4.3.2 High-energy Lasers

High energy laser weapons are designed to disable surface targets, rendering them immobile. The primary concern is the potential for an invertebrate to be struck with the laser beam at or near the water's surface, which could result in injury or death. Marine invertebrates could be exposed to the laser only if the beam misses the target. Should the laser strike the sea surface, individual invertebrates at or near the surface, such as jellyfish, floating eggs, and larvae could potentially be exposed. The potential for exposure to a high energy laser beam decreases as water depth increases. Most marine invertebrates are not susceptible to laser exposure because they occur beneath the sea surface.

High-energy laser weapons tests would be conducted along the Northeast U.S. Continental Shelf Large Marine Ecosystem and Gulf Stream Open Ocean Area specifically within the VACAPES Range Complex.

Coral species do not occur within the VACAPES Range Complex, or near the sea surface and therefore would not be exposed. There is no overlap of high-energy laser device use with designated critical habitat for elkhorn and staghorn coral. Therefore, the U.S. Navy determined that high energy laser devices will not affect elkhorn and staghorn coral or critical habitat.

4.3.4.4 *Potential Effects of Physical Disturbance and Strike Stressors on Corals*

The U.S. Navy analyzed potential impacts of various types of physical disturbance and strike stressors associated with training and testing activities within the Study Area. Specific physical disturbance and strike stressors assessed for impacts to corals include (1) vessels and in-water devices, (2) military expended materials, and (3) seafloor devices.

4.3.4.5 *Potential Effects of Vessels and In-Water Devices on Corals*

Vessels and in-water devices have the potential to impact marine invertebrates by disturbing the water column or sediments, or directly striking organisms {Bishop, 2008 #155878}. Propeller wash (water displaced by propellers used for propulsion) from vessel movement and water displaced from vessel hulls can potentially disturb marine invertebrates in the water column and are a likely cause of zooplankton mortality {Bickel, 2011 #155879}. This localized and short-term exposure to vessel and propeller movements could displace, injure, or kill zooplankton, invertebrate eggs or larvae, and macro-invertebrates in the upper portions of the water column. Surface vessels represent the majority of Navy vessels used in the Study Area, and these have drafts up to approximately 40–50 ft. (12–15 m), meaning that physical strikes are limited to the uppermost portion of the ocean. Disturbance caused by propeller wash can extend to approximately twice this depth. The average depth of the Atlantic Ocean is approximately 3,339 m, so approximately 99.1 percent of the water column is too deep to be exposed to physical strike or disturbance from surface vessels.

There are few sources of information on the impact of non-lethal chronic disturbance to marine invertebrates. One study of seagrass-associated marine invertebrates found that chronic disturbance from vessel wakes resulted in the long-term displacement of some marine invertebrates from the impacted area {Bishop, 2008 #155878}. Impacts of this type resulting from repeated exposure in shallow water are unlikely to result from Navy training and testing activities, because most vessel movements in shallow water are concentrated in well-established port facilities and associated channels {Mintz, 2006 #155875}.

The Navy concluded that vessels and in-water devices do not normally collide with corals that inhabit the seafloor because Navy vessels are operated in relatively deep waters and have navigational capabilities to avoid contact with these habitats. A consequence of vessel operation in shallow water is increased turbidity from stirring up bottom sediments. Turbidity can impact corals on hard bottom areas by reducing the amount of light that reaches these organisms and by increasing the effort the organism expends on sediment removal {Riegl, 1995 #155877}. Reef-building corals are sensitive to water clarity because of their symbiotic algae (i.e., zooxanthellae) that require sunlight to live. Encrusting organisms residing on hard bottom can be impacted by persistent silting from increased turbidity. In addition, propeller wash and physical contact with coral and hard bottom areas can cause structural damage to the substrate, as well as mortality to encrusting organisms.

Typical Navy navigational procedures minimize the likelihood of contacting the seafloor, and most Navy vessel movements in nearshore waters are confined to established channels and ports or predictable transit lanes within the Northeast U.S. Continental Shelf and Southeast U.S. Continental Shelf Large Marine Ecosystems, primarily between Norfolk, Virginia, and Jacksonville, Florida {Mintz, 2006 #155875}. Approximately 80 percent of Naval Surface Warfare Center, Panama City Division Testing Range surface activities occur beyond St. Andrew Bay and the inshore surf zone (the nearshore area of the beach where waves break, typically about 60-600 ft. [20-200 m]) {Dean, 2004 #155876}, while approximately 20 percent of surface operations may enter estuarine and nearshore waters.

The Navy assessment states that amphibious vessels would make contact with the seafloor in the surf zone during amphibious assault and amphibious raid operations. Benthic invertebrates, such as crabs, clams, and polychaete worms, within the disturbed area could be displaced, injured, or killed during amphibious operations. Amphibious operations take place in a limited area in the Southeast U.S. Continental Shelf Large Marine Ecosystem along Onslow Beach in North Carolina and at Naval Station Mayport, Florida, both long-established training beaches. Benthic invertebrates inhabiting these areas are adapted to a highly variable environment and are expected to rapidly re-colonize disturbed areas by immigration and larval recruitment. Studies indicate that benthic communities of high energy sandy beaches recover relatively quickly (typically within two to seven months) following beach nourishment (ACOE 2001). Schoeman et al. {, 2000 #155873} found that the macrobenthic (visible organisms on the seafloor) community required between 7 and 16 days to recover following excavation and removal of sand from a 2,153 ft.2 (200 m2) quadrant from the intertidal zone of a sandy beach.

Lastly, the Navy concluded that unmanned underwater vehicles travel at relatively low speeds and are smaller than most vessels, making the risk of strike or physical disturbance to marine invertebrates very low. Zooplankton, invertebrate eggs or larvae, and macro-invertebrates in the water column could be displaced, injured, or killed by unmanned underwater vehicle movements.

There is no overlap in the use of vessels and in-water devices with designated critical habitat for elkhorn and staghorn coral because vessels and inwater devices do not contact the seafloor during training and testing activities. Amphibious vehicles are an exception, but beaches are not critical habitat for elkhorn and staghorn coral. Therefore, the Navy determined that vessels and in-water devices will not affect elkhorn and staghorn coral critical habitat.

4.3.4.6 ***Potential Effects of Military Expended Material on Corals***

The U.S. Navy analyzed the strike potential to marine invertebrates including corals for the following categories of military expended materials: (1) non-explosive practice munitions, (2) fragments from high-explosive munitions, and (3) expended materials other than munitions, such as sonobuoys, vessel hulks, and expendable targets.

The spatial extent of military expended materials deposition includes all of the Study Area. Despite this broad range, the majority of military expended materials deposition occurs within established range complexes and testing ranges. Physical disturbance or strikes by military expended materials on marine invertebrates is possible at the water's surface, through the water column, and at the seafloor.

The Navy concluded that sessile marine invertebrates such as corals are particularly susceptible to military expended material strike. This includes shallow-water corals, hard bottom, and deep-water corals. Physical disturbance and strikes on deep-water corals (both military expended materials and marine debris) were inferred during a recent mapping expedition where objects were observed resting on and near deep-water invertebrates {Navy, 2011 #155872}. Most shallow-water coral reefs in the Study Area are within or adjacent to the Key West Range Complex, where the greatest numbers of military expended materials are primarily lightweight flares and chaff, which have inconsequential strike potential.

The Navy analysis indicates that potential impacts of projectiles to marine invertebrates on shallow-water corals, hard bottom, or deepwater corals present the greatest risk of long-term damage compared with other seafloor communities because (1) many corals and hard bottom invertebrates are sessile, fragile, and particularly vulnerable; (2) many of these organisms are slow-growing and could require decades to recover {Precht, 2003 #155871}; and (3) military expended materials are likely to remain mobile for a longer time because natural encrusting and burial processes are much slower on hard substrates than on soft bottom habitats.

Direct ordnance strikes from bombs, missiles, and rockets are potential stressors to marine invertebrates. The nature of their potential impacts is the same as projectiles; however, their size in both non-explosive and high-explosive forms is greater than most projectiles and high-explosive bombs, missiles, and rockets are likely to produce a greater number of small fragments than do projectiles. Propelled fragments are produced by high-explosives. Close to the explosion, invertebrates could potentially sustain injury from propelled fragments. However, studies of underwater bomb blasts have shown that fragments are larger than those produced during air blasts and decelerate much more rapidly (Swisdak Jr. and Montaro 1992){O'Keefe, 1984 #155870}, reducing the risk to marine organisms. Bombs, missiles, and rockets are designed to explode within 3 ft. (1 m) of the sea surface, where large marine invertebrates are relatively infrequent.

Sinking exercises (SINKEX) occur in specific open ocean areas, outside of the coastal range complexes. SINKEX activities have the potential to impact benthic invertebrates as the ship hulk lands on the seafloor. As the vessel hulk settles on the seafloor, all marine invertebrates within the footprint of the hulk would be impacted by strike or burial, and invertebrates a short distance beyond the footprint of the hulk would be disturbed. The Navy concluded that it is likely that habitat-forming invertebrates are absent where sinking exercises are planned because this activity occurs in depths greater than the range of corals and most other habitat-forming invertebrates (approximately 3,000 m) and away from known hydrothermal vent communities.

Activities that expend sonobuoy and air-launched torpedo parachutes generally occur in water deeper than 183 m. The Navy indicates that because they are in the air and water column for a time span of minutes, it is improbable that such a parachute deployed over water deeper than 183 m could travel far enough to affect shallow-water corals, including the ESA-listed elkhorn coral, staghorn coral, and the seven candidate coral species. Parachutes may impact marine invertebrates by disturbance, strikes, burial/smothering, or abrasion. Movement of parachutes in the water may break more fragile invertebrates such as deep-water corals.

4.3.4.7 ***Potential Effects of Seafloor Devices on Corals***

Seafloor devices include items that are placed on, dropped on, or moved along the seafloor such as mine shapes, anchor blocks, anchors, bottom-placed instruments, bottom-crawling unmanned underwater vehicles, and bottom placed targets that are recovered (not expended). Placement or mooring of objects on the seafloor may impact benthic invertebrates, eggs, and larvae by disturbance, strike, burial, or abrasion of individuals at the site and may disturb marine invertebrates outside the footprint of the seafloor device.

All activities using seafloor devices in the Key West Range Complex and the South Florida Ocean Measurement Facility Testing Range could expose this substrate to disturbances that could degrade the quality of critical habitat. Precision anchoring is qualitatively different and potential impacts to the seafloor are more intense than for other seafloor devices. The training activity involves navigation to a preplanned position and deployment of the ship’s anchor. The ship’s crew is evaluated on the accuracy of the ship’s position after the anchor is deployed. Precision anchoring may result in short-term and localized disturbances to water column habitats and long-term disturbances to seafloor habitats. Bottom sediments would be disturbed, and localized increases in turbidity would occur when an anchor makes contact with the seafloor, but turbidity would quickly dissipate (i.e., time scales of minutes to hours) following the exercise. Seafloor habitat and associated marine invertebrates in designated anchorage areas are likely prevented from fully recovering due to long-term, historical use of the same areas for anchoring.

4.3.4.8 ***Critical Habitat***

NMFS designated critical habitat for elkhorn and staghorn corals in November 2008 in four areas: Florida, Puerto Rico, St. John/ St. Thomas, and St. Croix. The primary constituent element for elkhorn and staghorn coral critical habitat are “substrate of suitable quality and availability” meaning a consolidated hardbottom or dead coral skeleton that is free from fleshy macroalgae cover and sediment cover. This feature is essential to the conservation of these two species due to the extremely limited recruitment currently being observed.

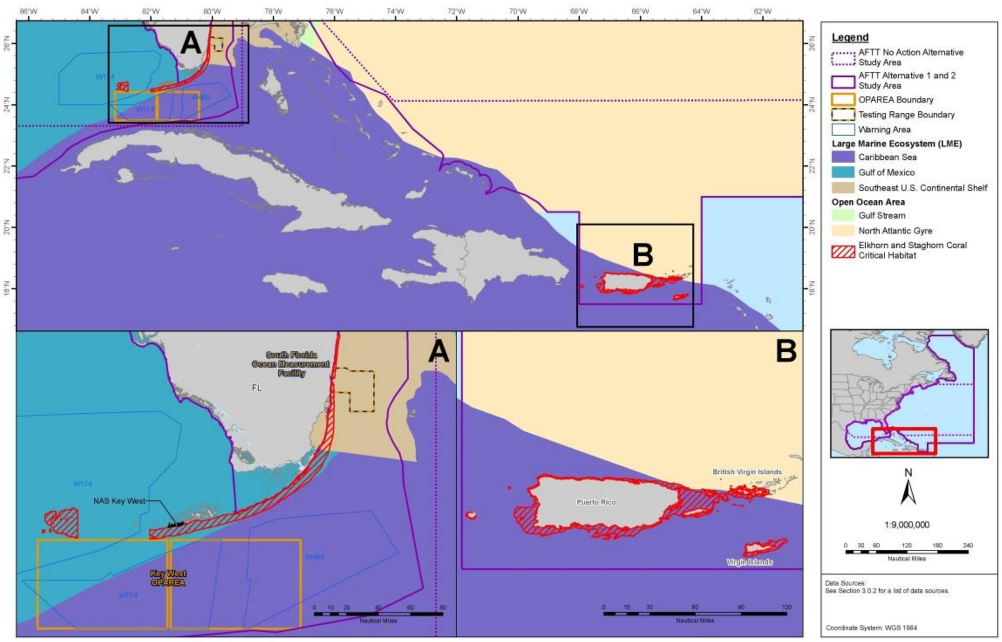

Figure 9. Critical Habitat for Elkhorn and Staghorn Coral in the AFTT Study Area

Exemptions from critical habitat designations include a small zone around Naval Air Station Key West, and the South Florida Ocean Measurement Facility Testing Range (Sections 3.8.2.3.1 and 3.8.2.4.1, Status and Management). All activities involving military expended materials, seafloor devices, and secondary stressors in the Key West Range Complex and the South Florida Ocean Measurement Facility Testing Range could expose this substrate to disturbances that could degrade the quality of critical habitat. However, the likelihood of exposure is reduced by mitigation measures, discussed in Navy Standard Operating Procedures, Mitigation, and Monitoring. It is unlikely that activities involving military expended materials, seafloor devices, and secondary stressors would reduce the conservation value of elkhorn and staghorn coral critical habitat.

4.3.4.9 *Conclusion*

The U.S. Navy determined that stressors resulting from military expended materials and seafloor devices may affect, but are not likely to adversely affect Lamarck's sheet coral (Agaricia lamarcki), boulder star coral (Montastraea annularis), mountainous star coral (Montastraea faveolata), star coral (Montastraea franksi), pillar coral (Dendrogyra cylindrus), elliptical star coral (Dichocoenia stokesii), rough cactus coral (Mycetophyllia ferox), staghorn coral (*Acropora cervicornis*) and elkhorn coral (*Acropora palmata*) by imposing fitness consequences on an individual that could result in "take." All other stressors were determined to have "no effect" since exposure or response to these potential stressors would not be expected.

With the exception of designated critical habitat for staghorn and elkhorn corals which are proposed for redesignation from threatened to endangered, critical habitat has not been proposed for these species yet and as such would not be affected. As we determined in the previous section, it is unlikely that activities involving military expended materials, seafloor devices, and secondary stressors would reduce the conservation value of elkhorn and staghorn coral critical habitat. Therefore, these stressors for coral species will not be addressed further in this opinion.

4.3.5 **Bowhead Whale**

4.3.5.1 ***Populations***

Currently, five bowhead whale stocks have been identified: Sea of Okhotsk, Davis Strait, Hudson Bay, offshore waters of Spitsbergen, and the western Arctic, with only the latter occurring in U.S. waters, and most stocks consist of a few dozens to hundreds of individuals (Ivashchenko and Clapham 2010; IWC 1992a; NMFS 2006i). Genetically, significant genetic differentiation exists between these areas (Givens et al. 2010; Ivashchenko and Clapham 2010). However, genetic analyses have thus far not clearly identified differences, particularly between Atlantic stocks, although some differentiation in haplotypes appears to exist between Hudson Bay and Davis Strait individuals in some areas (but not in all areas)(Bachmann et al. 2010; Heide-Jorgensen and Postma 2006; Postma and Cosens 2006). Genetic differentiation appears to be high within the western Arctic stock, which likely represents a single population (Givens et al. 2010).

4.3.5.2 ***Distribution***

Bowhead whales only occur at high latitudes in the northern hemisphere and have a disjunctive circumpolar distribution (Reeves 1980). Bowhead whales are found in the western Arctic (Bering, Chukchi, and Beaufort Seas), the Canadian Arctic and West Greenland (Baffin Bay, Davis Strait, and Hudson Bay), the Okhotsk Sea (eastern Russia), and the Northeast Atlantic from Spitzbergen westward to eastern Greenland. In the Chukchi Sea, bowheads are found in all months of the year (mainly west and southwest of Point Barrow) and distribution does not appear linked to changes in sea ice cover (Clarke and Ferguson. 2010b). Bowheads inhabiting the Okhotsk Sea appear to reside there year-round (Ivashchenko and Clapham 2010). Historically, bowhead whale range has extended into the eastern Atlantic, in which basin it is estimated that 52,500 individuals once lived (Allen et al. 2006).

Bowhead distribution extends into the northernmost portion of the action area, including shelf areas west of Greenland (sighted there in April) and northern Labrador (Ledwell et al. 2007). From May 2002 to December 2003, satellite-tracked bowheads travelled from western Greenland northwestward to Lancaster Sound. Individuals remained within the Canadian High Arctic or along the east coast of Baffin Island in summer and early fall, but moved rapidly south along the east coast of Baffin Island and entered Hudson Strait (Heide-Jorgensen et al. 2006).

4.3.5.3 ***Movement and Habitat***

The majority of the western Arctic stock migrates annually from wintering areas (November to March) in the northern Bering Sea, through the Chukchi in spring (March through June), to the Beaufort Sea where they spend much of the summer (mid-May through November) before returning again to the Bering Sea in fall. In the Chukchi Sea, bowheads are generally found in waters between 50 and 200 m deep (Clarke and Ferguson. 2010b). However, individuals in the Beaufort Sea appear to strongly favor shallower areas less than 50 m and preferably shallower than 20 m (Clarke and Ferguson. 2010a). Feeding appears to preferentially occur in 154-157º longitude in the Beaufort Sea (Clarke and Ferguson. 2010a). During their migrations north, they are forced between land and pack ice around Point Barrow, Alaska. They spend most of the summer in relatively ice-free waters of the Beaufort Sea, but they are associated with sea ice the rest of the year (Moore and Reeves 1993). During their autumn migration, bowhead whales preferentially select nearshore shelf waters, except if there are heavy ice conditions, in which case they select slope habitat. Not all bowhead whales follow this migration and some over-summer in the Bering and Chukchi Seas.

4.3.5.4 ***Growth and Reproduction***

Reproductive activities for bowhead whales occur throughout the year, but conception takes place in late winter or early spring. Some whales may be unable to conceive, as there is evidence of pseudohermaphroditism in a relatively high percentage (two of 76 whales sampled) of male bowhead whales (Philo et al. 1992). Gestation lasts 12 to 16 months and the calving interval is between 3.5 and seven years (Nerini et al. 1984; Tarpley et al. 1995). Bowhead whales take approximately two decades to become sexually mature, when they reach approximately 40 to 46 feet in length (IWC 2004a; Nerini et al. 1984; Schell and Saupe 1993; Schell et al. 1989). Disko Bay, Canada has been proposed as a breeding site for bowheads in the Baffin Bay stock and Foxe Bay has been proposed as a calf-rearing site (Heide-Jorgensen et al. 2010b).

4.3.5.5 ***Status and Trends***

Bowhead whales were originally listed as endangered in 1970 (35 FR 18319), and this status remained since the inception of the ESA in 1973. Bowhead whale abundance prior to commercial whaling in the western Arctic has been estimated at 10,400 to 23,000 (Woodby and Botkin 1993). At the end of commercial whaling the species had declined to between 1,000 and 3,000 bowhead whales in the western Arctic. The current minimum population estimate is 9,472 whales, and in 2001 the population was estimated at 10,545 individuals (Angliss and Outlaw 2008). The combined Davis Strait-Hudson Bay stocks are now thought to number at least 7,000 (Cosens et al. 2006). Also in 2001, 121 calves were counted, which is the most calves recorded in a single year. The population has been increasing at approximately 3.1% from 1978 to 1993 and more recently by about 3.5% annually (Angliss and Outlaw 2008). Punt (2010) estimated the rate of increase for bowhead whales in the Bering-Chukchi-Beaufort Sea region to be 3.9% annually (0.84 SE) between 1978 and 2001.

This upward population trend is consistent with impressions of local hunters and western Arctic recovery may warrant delisting in the future (Gerber et al. 2007; Noongwook et al. 2007). It is also estimated that 1,229 individuals reside in the Spitsbergen stock, which also exceeds prior abundance estimates and sightings are occurring on a more regular basis (Gilg and Born 2005; Heide-Jorgensen et al. 2007). In 2009, a calf was spotted off northeast Greenland; the first observed in the Spitsbergen stock in 18 years (Boertmann and Nielsen 2010). Hansen et al. (2010) estimated 1,105 individuals in Isabella Bay, Canada in September 2009. The eastern Canada-western Greenland stock appears to be increasing robustly based upon age at sexual maturity and calving interval data (Koski et al. 2010).

4.3.5.6 ***Natural Threats***

Little is known of diseases and natural death in the western Arctic bowhead whale population, but the mortality rate is thought to be low (Koski et al. 1993). Bowhead whales have been subjects of killer whale attacks and, because of their robust size and slow swimming speed, tend to form small groups and fight killer whales when confronted and may cause killer whale mortality with their flukes (Ford and Reeves 2008). Individuals have been known to be trapped by sea ice for extended periods, which may pose a lethal threat.

4.3.5.7 ***Anthropogenic Threats***

Bowhead whales began declining precipitously with directed whaling efforts in the Bering Sea between 1850 and 1870, when an estimated 60% of individuals were harvested (Braham 1984). Harvests declined after 1870, although whaling efforts continued, including illegal Soviet whaling (Ivashchenko and Clapham 2010). Subsistence harvests continue at present, with 31 of 38 whales struck by Alaskan native harpoons killed and landed in 2009, which is roughly similar to annual landings over the past decade (Suydam et al. 2004; Suydam et al. 2009; Suydam et al. 2010; Suydam et al. 2005; Suydam et al. 2006; Suydam et al. 2003; Suydam and George. 2004; Suydam et al. 2002).

Present threats to bowhead whales include interactions with crab pots, nets, and ship propellers at low levels. Between 1978 and 2004, eight bowheads were observed entangled and five had propeller scars (NMFS 2006i). These bowheads likely became entangled as a result of "skimming" prey at the water's surface and becoming entangled with debris. More significant are the number of bowhead whales taken by native tribes from the western Arctic stock: 14 to 72 individuals, or 0.1 to 0.5% of the stock population annually. Under this system, 832 individuals are known to have been taken from 1974 to 2003. However, these hunts are closely monitored and accessed for negative impacts on population number and structure and serve to maintain tribal culture. Individuals are known to have been taken by native tribes in Canada and Russia, although in extremely low numbers. Another potential threat is the documented reduction in sea ice, weather, or temperature conditions that has resulted from global warming (Tynan and DeMaster 1997). It is unknown what effects these large scale changes may have (NMFS 2006i).

Several contaminants have been isolated from bowhead whale tissues in low concentrations, including organochlorines, mercury, lead, arsenic, zinc, copper, cadmium, selenium, and silver (Dehn et al. 2006; O'Hara et al. 2006; Rosa et al. 2007b). Rosa et al. (2008) measured metal concentrations in the liver that included zinc (6.99 to 135.11 mg/kg wet weight), copper (1.09 to 203.81 mg/kg), cadmium (0.003 to 50.91 mg/kg), selenium (0.06 to 3.77 mg/kg), silver (0.05 to 2.37 mg/kg), and mercury (0.001 to 0.47 mg/kg). These same metals in kidney are generally lower, but present; zinc (9.07 to 56.31 mg/kg wet weight), copper (0.76 to 7.94 mg/kg), cadmium (0.01 to 64.0 mg/kg), selenium (0.23 to 3.21 mg/kg), silver (0.01 to 0.06 mg/kg), and mercury (0.001 to 0.14 mg/kg). Thickening of the Bowman's capsules and fibrous tissue formations are associated with cadmium accumulation in the kidney. These changes may reduce kidney function, although bowheads seem to be able to withstand significant kidney pathology (Parrish et al. 2008). Bioaccumulation of these metals occurs with age, but differences between sexes have not been observed in metal concentration (Parrish et al. 2008). These concentrations are lower than in other studied cetaceans due to the lower level at which bowhead whales feed in the overall food chain (Dehn et al. 2006; Parrish et al. 2008). Hormonal concentrations suggest that contaminants are not presently a significant hindrance for bowhead whales (Rosa et al. 2007a). However, the development of Arctic regions for oil and gas can increase contaminant loads in the environment, prey species, and protected species such as bowhead whales. Organochlorine levels are also believed to accumulate in arctic regions (Tanabe et al. 1994), leading to concern over the potential bioaccumulation of these toxins in bowhead whales due to global sources.

Bowhead whales have also been shown to vacate areas in which drilling and seismic survey operations occur, apparently in response to sound (Davies 1997; Miller et al. 1999b; Richardson 1995b; Richardson and Malme 1993; Schick and Urban 2000). It is possible that migratory routes have already shifted in response to anthropogenic sound (Richardson et al. 2004a).

4.3.5.8 ***Conclusion***

The Navy modeled acoustic impacts within representative locations where training and testing has historically occurred in the past and is expected to occur in the future. Within the Study Area, the expected geographic extent of some species including bowhead whales did not overlap with any area where potential acoustic impacts were modeled. Therefore, since there were no expected impacts from the modeled sources, bowhead whales were excluded from quantitative analysis and this opinion. Other stressors such as vessel strike are discountable due to the very low frequency and duration of vessel traffic in areas where bowhead occur and the low densities of animals where vessels frequent. Therefore, stressors associated with training and testing in AFTT study area are not likely to adversely affect bowhead whales and as such are not addressed further in this opinon.

4.4 Listed Species Considered Further in this Opinion

Based on the anticipated exposure and response of species to stressors, we identified endangered and threatened species or critical habitat that are likely to be adversely affected by proposed Atlantic Fleet training and testing.

This section of our Opinion consists of narratives for each of the threatened and endangered species that occur in the action area and that may be adversely affected by the readiness activities the U.S. Navy proposes to conduct in the AFTT Study Area. In each narrative, we present a summary of information on each species to provide a foundation for the exposure analyses that appear later in this opinion. We present information on the diving and social behavior of the different species because that behavior helps determine whether aerial and ship board surveys are likely to detect each species. We also summarize information on the vocalizations and hearing of the different species because that background information lays the foundation for our assessment of the how the different species are likely to respond to sounds produced by the Navy's training exercises and testing activities. Then we summarize information on the threats to the species and the species' status given those threats to provide points of reference for the jeopardy determinations we make later in this opinion. That is, we rely on a species' status and trend to determine whether or not an action's direct or indirect effects are likely to increase the species' probability of becoming extinct.

4.4.1 Blue Whale

4.4.1.1 *Subspecies*

Several blue whale subspecies have been characterized from morphological and geographical variability, but the validity of blue whale subspecies designations remains uncertain (McDonald et al. 2006). The largest, the Antarctic or true blue whale (*Balaenoptera musculus intermedia*), occurs in the highest Southern Hemisphere latitudes (Gilpatrick and Perryman. 2009). During austral summers, "true" blue whales occur close to Antarctic ice. A slightly smaller blue whale, *B. musculus musculus*, inhabits the Northern Hemisphere (Gilpatrick and Perryman. 2009). The pygmy blue whale (B. *musculus brevicauda*), may be geographically distinct from *B. m. musculus* (Kato et al. 1995). Pygmy blue whales occur north of the Antarctic Convergence (60°-80° E and 66°-70° S), while true blue whales are south of the Convergence (58° S) in the austral summer (Kasamatsu et al. 1996; Kato et al. 1995). A fourth subspecies, *B. musculus indica*, may exist in the northern Indian Ocean (McDonald et al. 2006).

4.4.1.2 *Population Structure*

Little is known about population and stock structure[3] of blue whales. Studies suggest a wide range of alternative population and stock scenarios based on movement, feeding, and acoustic data. Some suggest that as many as 10 global populations, while others suggest that the species is composed of a single panmictic population (Gambell 1979; Gilpatrick and Perryman. 2009; Reeves et al. 1998). For management purposes, the International Whaling Commission (IWC) considers all Pacific blue whales to be a single stock, whereas under the MMPA, the NMFS recognizes four stocks of blue whales: western North Pacific Ocean, eastern North Pacific Ocean, Northern Indian Ocean, and Southern Hemisphere.

Until recently, blue whale population structure had not been tested using molecular or nuclear genetic analyses (Reeves et al. 1998). A recent study by Conway (2005) suggested that the global population could be divided into four major subdivisions, which roughly correspond to major ocean basins: eastern North and tropical Pacific Ocean, Southern Indian Ocean, Southern Ocean, and western North Atlantic Ocean. The eastern North/tropical Pacific Ocean subpopulation includes California, western Mexico, western Costa Rica, and Ecuador, and the western North Atlantic Ocean subpopulation (Conway 2005). Genetic studies of blue whales occupying a foraging area south of Australia (most likely pygmy blue whales) have been found

3"Populations" herein are a group of individual organisms that live in a given area and share a common genetic heritage. While genetic exchange may occur with neighboring populations, the rate of exchange is greater between individuals of the same population than among populations---a population is driven more by internal dynamics, birth and death processes, than by immigration or emigration of individuals. To differentiate populations, NMFS considers geographic distribution and spatial separation, life history, behavioral and morphological traits, as well as genetic differentiation, where it has been examined. In many cases, the behavioral and morphological differences may evolve and be detected before genetic variation occurs. In some cases, the term "stock" is synonymous with this definition of "population" while other usages of "stock" are not.

to belong to a single population (Attard et al. 2010). For this Opinion, blue whales as treated four distinct populations as outlined by Conway (2005).

North Atlantic. Blue whales are found from the Arctic to at least mid-latitude waters, and typically inhabit the open ocean with occasional occurrences in the U.S. EEZ (Gagnon and Clark 1993; Wenzel et al. 1988b; Yochem and Leatherwood 1985b). Yochem and Leatherwood (1985b) summarized records suggesting winter range extends south to Florida and the Gulf of Mexico. The U.S. Navy's Sound Surveillance System acoustic system has detected blue whales in much of the North Atlantic, including subtropical waters north of the West Indies and deep waters east of the U.S. Atlantic EEZ (Clark 1995). Concentrations of blue whale sounds were detected in the Grand Banks off Newfoundland and west of the British Isles. Blue whales are rare in the shelf waters of the eastern U.S. In the western North Atlantic, blue whales are most frequently sighted from the Gulf of St. Lawrence and eastern Nova Scotia and in waters off Newfoundland, during the winter (Sears et al. 1987). In the summer month, they have been observed in Davis Strait (Mansfield 1985), the Gulf of St. Lawrence (from the north shore of the St. Lawrence River estuary to the Strait of Belle Isle), and off eastern Nova Scotia (Sears et al. 1987). In the eastern North Atlantic, blue whales have been observed off the Azores, although Reiner et al. (1993) did not consider them common in that area. Observations of feeding have recently occurred over Ireland's western continental slope (Wall et al. 2009).

Within the action area, blue whales occur occasionally to rarely in the U.S. EEZ, with only five August sightings during extensive surveys (CETAP 1982a; Wenzel et al. 1988a). Yochem and Leatherwood (1985a) suggested potential rare occurrence south to Florida and the Gulf of Mexico.

4.4.1.3 ***Age***

Blue whales may reach 70–80 years of age (COSEWIC 2002; Yochem and Leatherwood 1985b).

4.4.1.4 ***Reproduction***

Gestation takes 10-12 months, followed by a 6-7 month nursing period. Sexual maturity occurs at 5-15 years of age and calves are born at 2-3 year intervals (COSEWIC 2002; NMFS 1998c; Yochem and Leatherwood 1985b). Recent data from illegal Russian whaling for Antarctic and pygmy blue whales support sexual maturity at 23 m and 19-20 m, respectively (Branch and Mikhalev 2008).

4.4.1.5 ***Movement***

Blue whales are highly mobile, and their migratory patterns are not well known (Perry et al. 1999; Reeves et al. 2004). Blue whales migrate toward the warmer waters of the subtropics in fall to reduce energy costs, avoid ice entrapment, and reproduce (NMFS 1998a). Satellite tagging indicates that, for blue whales tagged off Southern California, movement is more linear and faster (3.7 km/h) while traveling versus while foraging (1.7 km/h)(Bailey et al. 2009). Residency times in what are likely prey patches averages 21 days and constituted 29% of an individual's time overall, although foraging could apparently occur at any time of year for tagged individuals (Bailey et al. 2009). Broad scale movements also varied greatly, likely in response to oceanographic conditions influencing prey abundance and distribution (Bailey et al. 2009). Blue whales along Southern California were found to be traveling 85% of the time and milling 11% (Bacon et al. 2011).

4.4.1.6 *Vocalization and Hearing*

Blue whales produce prolonged low-frequency vocalizations that include moans in the range from 12.5-400 Hz, with dominant frequencies from 16-25 Hz, and songs that span frequencies from 16-60 Hz that last up to 36 sec repeated every 1 to 2 min (see Cummings and Thompson 1971; Cummings and Thompson 1977; Edds-Walton 1997a; Edds 1982; McDonald et al. 1995a; Thompson and Friedl 1982). Berchok et al. (2006) examined vocalizations of St. Lawrence blue whales and found mean peak frequencies ranging from 17.0-78.7 Hz. Reported source levels are 180-188 dB re 1µPa, but may reach 195 dB re 1µPa (Aburto et al. 1997; Clark and Ellison 2004; Ketten 1998b; McDonald et al. 2001b). Samaran et al. (2010) estimated Antarctic blue whale calls in the Indian Ocean at 179 ± 5 dB re 1 μPa_{rms} at 1 m in the 17-30 Hz range and pygmy blue whale calls at 175± 1 dB re 1 μPa_{rms} at 1 m in the 17-50 Hz range.

In temperate waters, intense bouts of long patterned sounds are very common from fall through spring, but these also occur to a lesser extent during the summer in high latitude feeding areas. Short sequences of rapid calls in the 30-90 Hz band are associated with animals in social groups. The seasonality and structure of long patterned sounds suggest that these sounds are male displays for attracting females, competing with other males, or both. The context for the 30-90 Hz calls suggests that they are communicative but not related to a reproductive function. Vocalizations attributed to blue whales have been recorded in presumed foraging areas, along migration routes, and during the presumed breeding season (Beamish and Mitchell 1971; Cummings et al. 1972; Cummings and Thompson 1971; Cummings and Thompson 1977; Cummings and Thompson 1994; Rivers 1997; Thompson et al. 1996).

As with other baleen whale vocalizations, blue whale vocalization function is unknown, although numerous hypotheses exist (maintaining spacing between individuals, recognition, socialization, navigation, contextual information transmission, and location of prey resources (Edds-Walton 1997b; Payne and Webb 1971; Thompson et al. 1992a). Intense bouts of long, patterned sounds are common from fall through spring in low latitudes, but these also occur less frequently while in summer high-latitude feeding areas. Short, rapid sequences of 30-90 Hz calls are associated with socialization and may be displays by males based upon call seasonality and structure.

Blue whale calls appear to vary between western and eastern North Pacific regions, suggesting possible structuring in populations (Rivers 1997; Stafford et al. 2001).

Direct studies of blue whale hearing have not been conducted, but it is assumed that blue whales can hear the same frequencies that they produce (low-frequency) and are likely most sensitive to this frequency range (Ketten 1997b; Richardson et al. 1995d).

Blue whales responded to a mid-frequency sound source, with a source level between 160-210 dB re 1 µPa at 1 m and a received sound level up to 160 dB re 1 µPa, by exhibiting generalized avoidance responses and changes to dive behavior during controlled exposure experiments (CCE) (Goldbogen et al. 2013). However, reactions were not consistent across individuals based on received sound levels alone, and likely were the result of a complex interaction between sound exposure factors such as proximity to sound source and sound type (mid-frequency sonar simulation vs. pseudo-random noise), environmental conditions, and behavioral state. Surface feeding whales did not show a change in behavior during CCEs, but deep feeding and non-feeding whales showed temporary reactions that quickly abated (Gambell 1976) after sound exposure. Distances of the sound source from the whales during CCEs were sometimes less than a mile.

4.4.1.7 ***Status and Trends***

Blue whales (including all subspecies) were originally listed as endangered in 1970 (35 FR 18319), and this status continues since the inception of the ESA in 1973.

Table 31 contains historic and current estimates of blue whales by region. Globally, blue whale abundance has been estimated at between 5,000-13,000 animals (COSEWIC 2002; Yochem and Leatherwood 1985b); a fraction of the 200,000 or more that are estimated to have populated the oceans prior to whaling (Maser et al. 1981; U.S. Department of Commerce 1983).

North Atlantic. Commercial hunting had a severe effect on blue whales, such that they remain rare in some formerly important habitats, notably in the northern and northeastern North Atlantic (Sigurjónsson and Gunnlaugsson 1990). Sigurjónsson and Gunnlaugsson (1990) estimated that at least 11,000 blue whales were harvested from all whaling areas from the late nineteenth to mid-twentieth centuries. The actual size of the blue whale population in the North Atlantic is uncertain, but estimates range from a few hundred individuals to about 2,000 (Allen 1970; Mitchell 1974a; Sigurjónsson 1995; Sigurjónsson and Gunnlaugsson 1990). Current trends are unknown, although an increasing annual trend of 4.9% annually was reported for 1969–1988 off western and southwestern Iceland (Sigurjónsson and Gunnlaugsson 1990). Sigurjónsson and Gunnlaugsson (1990) concluded that the blue whale population had been increasing since the late 1950s. In the northeastern Atlantic, blue whales are most common west and south of Iceland and may be the largest concentration of blue whales in the North Atlantic (Pike et al. 2009b). In this area, the population may be recovering at a rate of 4-5% (Pike et al. 2009b). Punt (2010) estimated the rate of increase for blue whales in the central North Atlantic to be 9% annually (3.83 SE) between 1987 and 2001.

Table 31. Summary of past and present blue whale abundance.

Region	Population, stock, or study area	Pre-exploitation estimate	95% CI	Current estimate	95% CI	Source
Global	~~	200,000	~~	11,200-13,000	~~	(DOC 1983; Maser et al. 1981)
	~~	~~	~~	5,000-12,000	~~	(COSEWIC 2002)
North Atlantic	Basinwide	1,100-1,500	~~	100-555	~~	(Braham 1991; Gambell 1976)
	NMFS-western North Atlantic stock	~~	~~	308	~~	(Sears et al. 1987)
North Pacific	Basinwide	4,900	~~	1,400-1,900	~~	

	~~	~~	~~	3,300	~~	(Wade and Gerrodette 1993) and (Barlow 1997a) as combined in(Perry et al. 1999)
	Eastern tropical Pacific	~~	~~	1,415	1,078-2,501	(Wade and Gerrodette 1993)
	Costa Rica EEZ	~~	~~	48	22-102*	(Gerrodette and Palacios 1996)
	Central American EEZs north of Costa Rica	~~	~~	94	34-257*	(Gerrodette and Palacios 1996)
	Eastern North Pacific	~~	~~	2,997	2,175-3,819	(Calambokidis and Barlow 2004)
	NMFS-eastern North Pacific stock	~~	~~	1,368	CV=0.22	(Carretta et al. 2008)
Southern Hemisphere	Basinwide	150,000-210,000		5,000-6,000	~~	(Gambell 1976; Yochem and Leatherwood 1985b)
	~~	300,000	~~	~~	~~	(COSEWIC 2002)
	~~	~~	~~	400-1,400	400-1,400	IWC, for years 1980-2000
	~~	~~	~~	1,700	860-2,900	(IWC 2005c), point estimate for 1996
	Within IWC survey areas	~~	~~	1,255	~~	(IWC 1996)
	~~	10,000	~~	5,000	~~	(Gambell 1976)
	~~	13,000	~~	6,500	~~	(Zemsky and Sazhinov 1982)

***Note: Confidence Intervals (C.I.) not provided by the authors were calculated from Coefficients of Variation (C.V.) where available, using the computation from Gotelli and Ellison (2004).**

4.4.1.8 ***Natural Threats***

As the world's largest animals, blue whales are only occasionally known to be killed by killer whales (Sears et al. 1990; Tarpy 1979). Blue whales engage in a flight response to evade killer whales, which involves high energetic output, but show little resistance if overtaken (Ford and Reeves 2008). Blue whales are known to become infected with the nematode *Carricauda boopis*, which are believed to have caused mortality in fin whale due to renal failure (Lambertsen 1986).

4.4.1.9 ***Anthropogenic Threats***

Blue whales have faced threats from several historical and current sources. Blue whale populations are severely depleted originally due to historical whaling activity.

Increasing oceanic noise may impair blue whale behavior. Although available data do not presently support traumatic injury from sonar, the general trend in increasing ambient low-frequency noise in the deep oceans of the world, primarily from ship engines, could impair the ability of blue whales to communicate or navigate through these vast expanses (Aburto et al. 1997; Clark 2006). Blue whales off California altered call levels and rates in association with changes in local vessel traffic (Mckenna 2011).

Ship strikes were implicated in the deaths of five blue whales, from 2004-2008 (Carretta et al. 2011). Four of these deaths occurred in 2007, the highest number recorded for any year. During 2004-2008, there were an additional eight injuries of unidentified large whales attributed to ship strikes. Blue whale mortality and injuries attributed to ship strikes in California waters averaged 1.0 per year for 2004-2008. Additional mortality from ship strikes probably goes unreported because the whales do not strand or, if they do, they do not always have obvious signs of trauma. Studies have shown that blue whales respond to approaching ships in a variety of ways, depending on the behavior of the animals at the time of approach, and speed and direction of the approaching vessel. While feeding, blue whales react less rapidly and with less obvious avoidance behavior than whales that are not feeding (Sears 1983).

There is a paucity of contaminant data regarding blue whales. Available information indicates that organochlorines, including dichloro-diphenyl-trichloroethane (DDT), polychlorinated biphenyls (PCB), benzene hexachloride (HCH), hexachlorobenzene (HCB), chlordane, dieldrin, methoxychlor, and mirex have been isolated from blue whale blubber and liver samples (Gauthier et al. 1997c; Metcalfe et al. 2004). Contaminant transfer between mother and calf occurs, meaning that young often start life with concentrations of contaminants equal to their mothers, before accumulating additional contaminant loads during life and passing higher loads to the next generation (Gauthier et al. 1997b; Metcalfe et al. 2004).

4.4.2 **Fin Whale**

4.4.2.1 ***Subspecies***

There are two recognized subspecies of fin whales, *Balaenoptera physalus physalus*, which occurs in the North Atlantic Ocean, and *B. p. quoyi*, which occurs in the Southern Ocean. These subspecies and North Pacific fin whales appear to be organized into separate populations, although there is a lack of consensus in the published literature as to population structure.

4.4.2.2 ***Population Structure***

Population structure has undergone only a rudimentary framing. Genetic studies by Bérubé et al. (1998) indicate that there are significant genetic differences among fin whales in differing geographic areas (Sea of Cortez, Gulf of St. Lawrence, and Gulf of Maine). Further, individuals in the Sea of Cortez may represent an isolated population from other eastern North Pacific fin whales (Berube et al. 2002). Even so, mark-recapture studies also demonstrate that individual fin whales migrate between management units designated by the IWC (Mitchell 1974b; Sigujónsson and Gunnlaugsson 1989).

4.4.2.3 ***North Atlantic***

Fin whales are common off the Atlantic coast of the U.S. in waters immediately off the coast seaward to the continental shelf (about the 1,800 m contour).

Fin whales occur during the summer from Baffin Bay to near Spitsbergen (including Greenland, Iceland, northern Norway, Jan Meyers, and Spitzbergen) and the Barents Sea, south to Cape Hatteras in North Carolina and off the coasts of Portugal and Spain (Gambell 1985b; Rice 1998a). In areas north of Cape Hatteras, fin whales account for about 46% of the large whales observed in 1978-1982 surveys (CETAP 1982b). Little is known about the winter habitat of fin whales, but in the western North Atlantic, the species has been found from Newfoundland south to the Gulf of Mexico and Greater Antilles, and in the eastern North Atlantic their winter range extends from the Faroes and Norway south to the Canary Islands. Fin whales in the eastern North Atlantic have been found in highest densities in the Irminger Sea between Iceland and Greenland (Víkingsson et al. 2009). The singing location of fin whales in the Davis Strait and Greenland has been correlated with sea ice fronts; climate change may impact fin whale distribution and movement by altering sea ice conditions (Simon et al. 2010). A general fall migration from the Labrador and Newfoundland region, south past Bermuda, and into the West Indies has been theorized (Clark 1995). Historically, fin whales were by far the most common large whale found off Portugal (Brito et al. 2009).

Fin whales commonly occur in the action area, particularly in waters immediately off the coast seaward to roughly the 1,800 m isobath. Particularly high abundance is encountered north of Cape Hatteras, accounting for 46% of large whales observed in 1978-1982 surveys (Platonov et al. 2013). Summer sightings, apparently associated with major feeding areas along New England, occur in the Gulf of Maine, the Bay of Fundy, the Gulf of St. Lawrence and St. Lawrence Estuary, and in offshore areas of Nova Scotia, from shore seaward to the 1,000-fathom contour (Coakes et al. 2005; Johnston et al. 2005; Waring et al. 2010). Fidelity is high, with 49% of fin whales resighted in the feeding grounds of Massachusetts Bay within the same year, and 45% over multiple years (Waring et al. 2010).

Fin whales are also endemic to the Mediterranean Sea, where (at least in the western Mediterranean), individuals tend to aggregate during summer and disperse in winter over large spatial scales (Cotte et al. 2009). Mediterranean fin whales are genetically distinct from fin whales in the rest of the North Atlantic at the population level (Berube et al. 1999). However, some fin whales from the northeastern North Atlantic have been tracked into the Mediterranean during winter and overlap in time and space with the Mediterranean population may exist (Castellote et al. 2010). Individuals also tend to associate with colder, saltier water, where steep changes in temperature, and where higher northern krill densities would be expected (Cotte et al. 2009). A genetically distinct population resides year-round in the Ligurian Sea (IWC 2006a).

4.4.2.4 ***Age Distribution***

Aguilar and Lockyer (1987) suggested annual natural mortality rates in northeast Atlantic fin whales may range from 0.04 to 0.06. Fin whales live 70-80 years (Kjeld et al. 2006).

4.4.2.5 ***Reproduction***

Fin whales reach sexual maturity between 5-15 years of age (COSEWIC 2005a; Gambell 1985a; Lockyer 1972). Mating and calving occurs primarily from October-January, gestation lasts ~11 months, and nursing occurs for 6-11 months (Boyd et al. 1999; Hain et al. 1992). The average calving interval in the North Atlantic is estimated at about 2-3 years (Agler et al. 1993; Christensen et al. 1992a). The location of winter breeding grounds is uncertain but mating is assumed to occur in pelagic mid-latitude waters (Perry et al. 1999). This was recently contradicted by acoustic surveys in the Davis Strait and off Greenland, where singing by fin whales peaked in November through December; the authors suggested that mating may occur prior to southbound migration (Simon et al. 2010). Although seasonal migration occurs between presumed foraging and breeding locations, fin whales have been acoustically detected throughout the North Atlantic Ocean and Mediterranean Sea year-round, implying that not all individuals follow a set migratory pattern (Notarbartolo-Di-Sciara et al. 1999; Simon et al. 2010).

4.4.2.6 ***Behavior***

Fin whales along Southern California were found to be traveling 87% of the time and milling 5% in groups that averaged 1.7 individuals (Bacon et al. 2011). Most fin whales in the Southern Hemisphere migrate seasonally from Antarctic feeding areas in the summer to low-latitude breeding and calving grounds in winter. Fin whales tend to avoid tropical and pack-ice waters, with the high-latitude limit of their range set by ice and the lower-latitude limit by warm water of approximately 15° C (Sergeant 1977). Fin whale concentrations generally form along frontal boundary, or mixing zones between coastal and oceanic waters, which corresponds roughly to the 200 m isobath (the continental shelf edge (Cotte et al. 2009; Nasu 1974).

4.4.2.7 ***Vocalization and Hearing***

Fin whales produce a variety of low-frequency sounds in the 10-200 Hz range (Edds 1988; Thompson et al. 1992a; Watkins 1981a; Watkins et al. 1987b). Typical vocalizations are long, patterned pulses of short duration (0.5-2 s) in the 18-35 Hz range, but only males are known to produce these (Croll et al. 2002; Patterson and Hamilton 1964). Richardson et al. (1995c) reported the most common sound as a 1 s vocalization of about 20 Hz, occurring in short series during spring, summer, and fall, and in repeated stereotyped patterns during winter. Au (2000) reported moans of 14-118 Hz, with a dominant frequency of 20 Hz, tonal vocalizations of 34-150 Hz, and songs of 17-25 Hz (Cummings and Thompson 1994; Edds 1988; Watkins 1981a). Source levels for fin whale vocalizations are 140-200 dB re 1μPa·m (Clark and Ellison. 2004; Erbe 2002b). The source depth of calling fin whales has been reported to be about 50 m (Watkins et al. 1987b). In temperate waters intense bouts of long patterned sounds are very common from fall through spring, but also occur to a lesser extent during the summer in high latitude feeding areas (Clarke and Charif 1998). Short sequences of rapid pulses in the 20-70 Hz band are associated with animals in social groups (McDonald et al. 1995b). Each pulse lasts on the order of one second and contains twenty cycles (Tyack 1999).

Although their function is still debated, low-frequency fin whale vocalizations travel over long distances and may aid in long-distance communication (Edds-Walton 1997b; Payne and Webb 1971). During the breeding season, fin whales produce pulses in a regular repeating pattern, which have been proposed to be mating displays similar to those of humpbacks (Croll et al.

2002). These vocal bouts last for a day or longer (Tyack 1999). The seasonality and stereotype of the bouts of patterned sounds suggest that these sounds are male reproductive displays (Watkins et al. 1987a), while the individual counter-calling data of McDonald *et al.* (1995b)suggest that the more variable calls are contact calls. Some authors feel there are geographic differences in the frequency, duration and repetition of the pulses (Thompson et al. 1992b).

Direct studies of fin whale hearing have not been conducted, but it is assumed that fin whales can hear the same frequencies that they produce (low) and are likely most sensitive to this frequency range (Ketten 1997b; Richardson et al. 1995d).

4.4.2.8 *Status and Trends*

Fin whales were originally listed as endangered in 1970 (35 FR 18319), and this status continues since the inception of the ESA in 1973. Although fin whale population structure remains unclear, various abundance estimates are available (Table 32). Consideration of the status of populations outside of the action area is important under the present analysis to determine how the risk to the affected population(s) bears on the status of the species as a whole. Pre-exploitation fin whale abundance is estimated at 464,000 individuals worldwide; the estimate for 1991 was roughly 25% of this (Braham 1991). Historically, worldwide populations were severely depleted by commercial whaling, with more than 700,000 whales harvested in the twentieth century (Cherfas 1989b; Cherfas 1989a).

Table 32. Summary of Past and Present Fin Whale Abundance.

Region	Population, stock, or study area	Pre-exploitation estimate	95% CI	Recent estimate	95% CI	Source
Global	~~	>464,000	~~	119,000	~~	(Braham 1991)
North Atlantic	Basinwide	30,000-50,000	~~	~~	~~	(Sergeant 1977)
	~~	360,000	249,000-481,000	~~	~~	(Roman and Palumbi 2003)
	Central and northeastern Atlantic	~~	~~	30,000	23,000-39,000	(IWC 2007)
	Western North Atlantic	~~	~~	3,590-6,300	~~	(Braham 1991)
	NMFS-western North Atlantic stock	~~	~~	2,269	CV=0.37	(NMFS 2008a)
	Northeastern U.S. Atlantic cont'l shelf	~~	~~	2,200-5,000	~~	(Hain et al. 1992; Waring et al. 2000)
	IWC-Newfoundland-Labrador stock	~~	~~	13,253	0-50,139*	(IWC 1992b)
	IWC-British Isles, Spain, and Portugal stock	10,500	9,600-11,400	4,485	3,369-5,600	(Braham 1991)
	~~	~~	~~	17,355	10,400-28,900	(Buckland et al. 1992)
	IWC-east Greenland and Iceland stock	~~	~~	11,563	5,648-17,478*	(Gunnlaugsson and Sigurjónsson

						1990)
	IWC-west Greenland stock stock	~~	~~	1,700	840-3,500	(IWC 2006a)
North Pacific	Basinwide	42,000-45,000	~~	16,625	14,620-18,630	(Braham 1991; Ohsumi and Wada 1974)
	Central Bering Sea	~~	~~	4,951	2,833-8,653	(Moore et al. 2002)
	NMFS-northeast Pacific stock, west of Kenai Peninsula	~~	~~	5,700	~~	(Angliss and Allen 2007)
	NMFS-CA/OR/WA stock	~~	~~	2,636	CV=0.15	(Carretta et al. 2008)
	NMFS-HI stock	~~	~~	174	0-420*	(Carretta et al. 2008)
Southern Hemisphere	Basinwide	400,000	~~	85,200	~~	(Braham 1991; IWC 1979)
	South of 60S	~~	~~	1,735	514-2,956	(IWC 1996)
	South of 30S	~~	~~	15,178	~~	(IWC 1996)
	Scotia Sea and Antarctic Peninsula	~~	~~	4,672	792-8,552	(Hedley et al. 2001; Reilly et al. 2004)

***Note: Confidence Intervals (C.I.) not provided by the authors were calculated from Coefficients of Variation (C.V.) where available, using the computation from Gotelli and Ellison (2004).**

4.4.2.9 *North Atlantic*

Sigurjónsson (1995) estimated that between 50,000 and 100,000 fin whales once populated the North Atlantic, although he provided no data or evidence to support that estimate. However, over 48,000 fin whales were caught between 1860-1970 (Braham 1991). Although protected by the IWC, from 1988-1995 there have been 239 fin whales harvested from the North Atlantic. Recently, Iceland resumed whaling of fin whales despite the 1985 moratorium imposed by the IWC. Forcada et al. (1996) estimated that 3,583 individuals (95% CI = 2,130- 6,027) inhabit the western Mediterranean Sea. Goujon et al. (1994) estimated 7,000-8,000 fin whales in the Bay of Biscay. Vikingsson et al. (2009) estimated roughly 20,000 fin whales to be present in a large portion of the eastern North Atlantic in 1995, which increased to roughly 25,000 in 2001. The authors concluded that actual numbers were likely higher due to negative bias in their analysis, and that the population(s) were increasing at 4% annually (Víkingsson et al. 2009). The abundance of fin whales in the Baffin Bay-Davis Strait summer feeding area is believed to be increasing (Heide-Jorgensen et al. 2010a).

4.4.2.10 *Natural Threats*

Natural sources and rates of mortality are largely unknown, but Aguilar and Lockyer (1987) suggested annual natural mortality rates might range from 0.04 to 0.06 for northeast Atlantic fin whales. The occurrence of the nematode *Crassicauda boopis* appears to increase the potential for kidney failure and may be preventing some fin whale populations from recovering (Lambertsen 1992). Adult fin whales engage in a flight responses (up to 40 km/h) to evade killer whales, which involves high energetic output, but show little resistance if overtaken (Ford and Reeves 2008). Shark attacks may also result in serious injury or death in very young and sick individuals (Perry et al. 1999).

4.4.2.11 ***Anthropogenic Threats***

Fin whales have undergone significant exploitation, but are currently protected under the IWC. Fin whales are still hunted in subsistence fisheries off West Greenland. In 2003, two males and four females were landed and two others were struck and lost (IWC 2005b). In 2004, five males and six females were killed, and two other fin whales were struck and lost. Between 2003 and 2007, the IWC set a catch limit of up to 19 fin whales in this subsistence fishery. However, the scientific recommendation was to limit the number killed to four individuals until accurate populations could be produced (IWC 2005b). In the Antarctic Ocean, fin whales are hunted by Japanese whalers who have been allowed to kill up to 10 fin whales each ear for the 2005-2006 and 2006-2007 seasons under an Antarctic Special Permit NMFS (2006b). Japanese whalers plan to kill 50 whales per year starting in the 2007-2008 season and continuing for the next 12 years (IWC 2006b; Nishiwaki et al. 2006).

Fin whales experience significant injury and mortality from fishing gear and ship strikes (Carretta et al. 2007; Douglas et al. 2008a; Lien 1994; Perkins and Beamish 1979; Waring et al. 2007). Similarly, 2.4% of living fin whales from the Mediterranean show ship strike injury and 16% of stranded individuals were killed by vessel collision (Panigada et al. 2006). There are also numerous reports of ship strikes off the Atlantic coasts of France and England (Jensen and Silber 2004b). Most of these fin whales (n = 43), were killed between 1972 and 2001 and the highest percentage (37 of 45 or ~82%) were killed in the Ligurian Sea and adjacent waters, where the Pelagos Sanctuary for Marine Mammals was established. In addition to these ship strikes, there are numerous reports of fin whales being injured as a result of ship strikes off the Atlantic coast of France and the United Kingdom (Jensen and Silber 2004a).

Increased noise in the ocean stemming from shipping seems to alter the acoustic patterns of singing fin whales, possibly hampering reproductive parameters across wide regions (Castellote et al. 2012).

The organochlorines DDE, DDT, and PCBs have been identified from fin whale blubber, but levels are lower than in toothed whales due to the lower level in the food chain that fin whales feed at (Aguilar and Borrell 1988; Borrell 1993; Borrell and Aguilar 1987; Henry and Best 1983; Marsili and Focardi 1996). Females contained lower burdens than males, likely due to mobilization of contaminants during pregnancy and lactation (Aguilar and Borrell 1988; Gauthier et al. 1997b; Gauthier et al. 1997c). Contaminant levels increase steadily with age until sexual maturity, at which time levels begin to drop in females and continue to increase in males (Aguilar and Borrell 1988).

Climate change also presents a potential threat to fin whales, particularly in the Mediterranean Sea, where fin whales appear to rely exclusively upon northern krill as a prey source. These krill occupy the southern extent of their range and increases in water temperature could result in their decline and that of fin whales in the Mediterranean Sea (Gambaiani et al. 2009).

4.4.3 Humpback Whale

4.4.3.1 *Population Designations*

Populations have been relatively well defined for humpback whales.

4.4.3.2 *North Atlantic*

Humpback whales range from the mid-Atlantic bight and the Gulf of Maine across the southern coast of Greenland and Iceland to Norway in the Barents Sea. Whales migrate to the western coast of Africa and the Caribbean Sea during the winter. Humpback whales aggregate in four summer feeding areas: Gulf of Maine and eastern Canada, west Greenland, Iceland, and Norway (Boye et al. 2010; Katona and Beard 1990; Smith et al. 1999).

Increasing range and occurrence in the Mediterranean Sea coincides with population growth and may represent reclaimed habitat from pre-commercial whaling (Frantzis et al. 2004; Genov et al. 2009). The principal breeding range for Atlantic humpback whales lies from the Antilles and northern Venezuela to Cuba (Balcomb III and Nichols 1982; Whitehead and Moore 1982; Winn et al. 1975). The largest breeding aggregations occur off the Greater Antilles where humpback whales from all North Atlantic feeding areas have been photo-identified (Clapham et al. 1993a; Katona and Beard 1990; Mattila et al. 1994; Palsbøll et al. 1997; Smith et al. 1999; Stevick et al. 2003b). However, the possibility of historic and present breeding further north remains enigmatic but plausible (Smith and G.Pike 2009). Winter aggregations also occur at the Cape Verde Islands in the eastern North Atlantic and along Angola (Cerchio et al. 2010; Reeves et al. 2002; Reiner et al. 1996; Weir 2007). Accessory and historical aggregations also occur in the eastern Caribbean (Levenson and Leapley 1978; Mitchell and Reeves 1983; Reeves et al. 2001a; Reeves et al. 2001b; Schwartz 2003a; Smith and Reeves 2003; Swartz et al. 2003; Winn et al. 1975). To further highlight the "open" structure of humpback whales, a humpback whale migrated from the Indian Ocean to the South Atlantic Ocean, demonstrating that interoceanic movements can occur (Pomilla and Rosenbaum 2005). Genetic exchange at low-latitude breeding groups between Northern and Southern Hemisphere individuals and wider-range movements by males has been suggested to explain observed global gene flow (Rizzo and Schulte 2009). However, there is little genetic support for wide-scale interchange of individuals between ocean basins or across the equator.

In the action area, the Gulf of St. Lawrence, Newfoundland Grand Banks, and Scotian Shelf are summer (particularly mid-April to mid-November) feeding grounds for humpbacks (CETAP 1982a; Kenney and Winn 1986; Stevick et al. 2006; Whitehead 1982). Secondary feeding locations include Stellwagen Bank, Jeffreys Ledge, the Great South Channel, the edges and shoals of Georges Bank, Cashes Ledge, and Grand Manan Banks (CETAP 1982a; Kenney and Winn 1986; Stevick et al. 2006; Weinrich et al. 1997; Whitehead 1982). Although potentially present year-round, humpbacks are most likely to occur in the Chesapeake Bay between January and March, with some degree of site fidelity (Barco et al. 2002; Schwarz and Arnason 1996).

4.4.3.3 *Reproduction*

Humpback whales migrate seasonally between warmer, tropical or sub-tropical waters in winter months (where they breed and give birth to calves, although feeding occasionally occurs) and cooler, temperate or sub-Arctic waters in summer months (where they feed; (Gendron and Urban

1993). In both regions, humpback whales tend to occupy shallow, coastal waters. However, migrations are undertaken through deep, pelagic waters (Winn and Reichley 1985).

Humpback whale calving and breeding generally occurs during winter at lower latitudes. Gestation takes about 11 months, followed by a nursing period of up to 1 year (Baraff and Weinrich 1993). Sexual maturity is reached at between 5-7 years of age in the western North Atlantic, but may take as long as 11 years in the North Pacific, and perhaps over 11 years (e.g., southeast Alaska, Gabriele et al. 2007). Females usually breed every 2-3 years, although consecutive calving is not unheard of (Clapham and Mayo 1987; 1990; Glockner-Ferrari and Ferrari 1985 as cited in NMFS 2005b; Weinrich et al. 1993). Males appear to return to breeding grounds more frequently than do females (Herman et al. 2011). Larger females tend to produce larger calves that may have a greater chance of survival (Pack et al. 2009). In some Atlantic areas, females tend to prefer shallow nearshore waters for calving and rearing, even when these areas are extensively trafficked by humans (Picanco et al. 2009).

In calving areas, males sing long complex songs directed towards females, other males, or both. The breeding season can best be described as a floating lek or male dominance polygamy (Clapham 1996). Calving occurs in the shallow coastal waters of continental shelves and oceanic islands worldwide (Perry et al. 1999). Males court females in escort groups and compete for proximity and presumably access to reproduce females (particularly larger females)(Pack et al. 2009). Although long-term relationships do not appear to exist between males and females, mature females do pair with other females; those individuals with the longest standing relationships also have the highest reproductive output, possibly as a result of improved feeding cooperation (Ramp et al. 2010).

4.4.3.4 ***Vocalization and Hearing***

Humpback whale vocalization is much better understood than is hearing. Different sounds are produced that correspond to different functions: feeding, breeding, and other social calls (Dunlop et al. 2008). Males sing complex sounds while in low-latitude breeding areas in a frequency range of 20 Hz to 4 kHz with estimated source levels from 144-174 dB (Au 2000; Au et al. 2006a; Frazer and Mercado 2000; Payne 1970; Richardson et al. 1995d; Winn et al. 1970a). Males also produce sounds associated with aggression, which are generally characterized as frequencies between 50 Hz to 10 kHz and having most energy below 3 kHz (Silber 1986a; Tyack 1983a). Such sounds can be heard up to 9 km away (Tyack and Whitehead 1983a). Other social sounds from 50 Hz to 10 kHz (most energy below 3 kHz) are also produced in breeding areas (Richardson et al. 1995d; Tyack and Whitehead 1983a). While in northern feeding areas, both sexes vocalize in grunts (25 Hz to 1.9 kHz), pulses (25-89 Hz), and songs (ranging from 30 Hz to 8 kHz but dominant frequencies of 120 Hz to 4 kHz) which can be very loud (175-192 dB re 1 μPa at 1 m; (Au 2000; Erbe 2002a; Payne and Payne 1985; Richardson et al. 1995d; Thompson et al. 1986a; Vu et al. 2012). However, humpbacks tend to be less vocal in northern feeding areas than in southern breeding areas, possibly due to foraging (Richardson et al. 1995d; Vu et al. 2012).

4.4.3.5 ***Status and Trends***

Humpback whales were originally listed as endangered in 1970 (35 FR 18319), and this status remains under the ESA. (Winn and Reichley 1985) argued that the global humpback whale population consisted of at least 150,000 whales in the early 1900s, mostly in the Southern Ocean. Consideration of the status of populations outside of the action area is important under the present analysis to determine how the risk to the affected population(s) bears on the status of the species as a whole. In 1987, the global population of humpback whales was estimated at about 10,000 (NMFS 1987). Although this estimate is outdated, it appears that humpback whale numbers are increasing. Table 33 provides estimates of historic and current abundance for ocean regions.

Table 33. Summary of past and present humpback whale abundance.

Region	Population, stock, or study area	Pre-exploitation estimate	95% CI	Recent estimate	95% CI	Source
Global	~~	1,000,000	~~	~~	~~	(Roman and Palumbi 2003)
North Atlantic	Basinwide	240,000	156,000-401,000*	11,570	10,005-13,135*	(Stevick et al. 2001) *in* (Waring et al. 2004)
	Basinwide-females	~~	~~	2,804	1,776-4,463	(Palsbøll et al. 1997)
	Basinwide-males	~~	~~	4,894	3,374-7,123	(Palsbøll et al. 1997)
	Western North Atlantic from Davis Strait, Iceland, to the West Indies	>4,685*	~~	~~	~~	*circa 1865; (Mitchell and Reeves 1983)
	NMFS-Gulf of Maine stock	~~	~~	845	CV=0.55	(NMFS 2008a)
	NMFS-Gulf of Maine stock including portions of the Scotian Shelf	~~	~~	902	177-1,627	(Clapham et al. 2003)
	Barents and Norweign Seas	~~	~~	889	331-1,447*	(Øien 2001) *in* (Waring et al. 2004)
North Pacific	Basinwide	15,000	~~	6,000-8,000	~~	(Calambokidis et al. 1997)
	NMFS-western North Pacific stock	~~	~~	394	329-459*	(Angliss and Allen 2007)
	NMFS-central North Pacific stock	~~	~~	4,005	3,259-4,751*	(Angliss and Allen 2007)

	NMFS-eastern North Pacific stock	~~	~~	1,391	1,331-1,451*	(Carretta et al. 2008)
Indian Ocean	Arabian Sea	~~	~~	56	35-255	Minton et al. (Minton et al. 2003) *in* (Bannister 2005)
Southern Hemisphere	Basinwide	100,000	~~	19,851	~~	(Gambell 1976; IWC 1996)
	South of 60S	~~	~~	4,660	2,897-6,423	(IWC 1996)

***Note: Confidence Intervals (C.I.) not provided by the authors were calculated from Coefficients of Variation (C.V.) where available, using the computation from Gotelli and Ellison (2004).**

4.4.3.6 *North Atlantic*

The best available estimate of North Atlantic abundance comes from 1992-1993 mark-recapture data, which generated an estimate of 11,570 humpback whales (Stevick et al. 2003a). Historical estimates have ranged from 40,000-250,000 (Smith and G.Pike 2009). Smith and Reeves (2010) estimated that roughly 31,000 individuals were removed from the North Atlantic due to whaling since the 1600s. Estimates of animals on Caribbean breeding grounds exceed 2,000 individuals (Balcomb III and Nichols 1982). Several researchers report an increasing trend in abundance for the North Atlantic population, which is supported by increased sightings within the Gulf of Maine feeding aggregation (Barlow 1997b; Katona and Beard 1990; Smith et al. 1999; Waring et al. 2001). The rate of increase varies from 3.2-9.4%, with rates of increase slowing over the past two decades (Barlow 1997b; Katona and Beard 1990; Stevick et al. 2003a). If the North Atlantic population has grown according to the estimated instantaneous rate of increase ($r = 0.0311$), this would lead to an estimated 18,400 individual whales in 2008 (Stevick et al. 2003a). Punt (2010) estimated the rate of increase for humpback whales in the Gulf of Maine to be 6.3% annually (1.2 SE). Pike et al. (2009a) suggested that the eastern and northeastern waters off Iceland are areas of significant humpback utilization for feeding, estimating nearly 5,000 whales in 2001 and proposing an annual growth rate of 12% for the area. The authors suggest that humpback whales in the area had probably recovered from whaling. However, recent data suggest that the upward growth may have slowed or ceased around Iceland according to analysis of survey data there (Pike et al. 2010).

4.4.3.7 *Natural Threats*

Natural sources and rates of mortality of humpback whales are not well known. Based upon prevalence of tooth marks, attacks by killer whales appear to be highest among humpback whales migrating between Mexico and California, although populations throughout the Pacific Ocean appear to be targeted to some degree (Steiger et al. 2008). Juveniles appear to be the primary age group targeted. Humpback whales engage in grouping behavior, flailing tails, and rolling extensively to fight off attacks. Calves remain protected near mothers or within a group and lone calves have been known to be protected by presumably unrelated adults when confronted with attack (Ford and Reeves 2008).

Parasites and biotoxins from red-tide blooms are other potential causes of mortality (Perry et al. 1999). The occurrence of the nematode *Crassicauda boopis* appears to increase the potential for kidney failure in humpback whales and may be preventing some populations from recovering (Lambertsen 1992). Studies of 14 humpback whales that stranded along Cape Cod between November 1987 and January 1988 indicate they apparently died from a toxin produced by dinoflagellates during this period. One-quarter of humpback whales of the Arabian Sea population show signs of tattoo skin disease, which may reduce the fitness of afflicted individuals (Baldwin et al. 2010).

4.4.3.8 ***Anthropogenic Threats***

Three human activities are known to threaten humpback whales: whaling, commercial fishing, and shipping. Historically, whaling represented the greatest threat to every population of whales and was ultimately responsible for listing several species as endangered.

There are also reports of entangled humpback whales from the Hawaiian Islands. In 1991, a humpback whale was observed entangled in longline gear and released alive (Hill et al. 1997). In 1995, a humpback whale in Maui waters was found trailing numerous lines (not fishery-related) and entangled in mooring lines. The whale was successfully released, but subsequently stranded and was attacked and killed by tiger sharks in the surf zone. Also in 1996, a vessel from Pacific Missile Range Facility in Hawaii rescued an entangled humpback, removing two crab pot floats from the whale. From 2001 through 2006, there were 23 reports of entangled humpback whales in Hawaiian waters; 16 of these reports were from 2005 and 2006.

Many of the entangled humpback whales observed in Hawaiian waters brought the gear with them from higher latitude feeding grounds; for example, the whale the U.S. Navy rescued in 1996 had been entangled in gear that was traced to a recreational fisherman in southeast Alaska. Thus far, 6 of the entangled humpback whales observed in the Hawaiian Islands have been confirmed to have been entangled in gear from Alaska. Nevertheless, humpback whales are also entangled in fishing gear in the Hawaiian Islands. Since 2001, there have been 5 observed interactions between humpback whales and gear associated with the Hawaii-based longline fisheries (NMFS 2008b). In each instance, however, all of the whales were disentangled and released or they were able to break free from the gear without reports of impairment of the animal’s ability to swim or feed.

Humpback whales are also killed or injured during interactions with commercial fishing gear. Between 1998 and 2005, observers identified 12 humpback whales injured or killed by fisheries off the US west coast (NMFS, unpublished data). An estimated 78 rorquals were killed annually in the offshore southern California drift gillnet fishery during the 1980s (Heyning and Lewis. 1990). From 1996-2000, 22 humpback whales of the Central North Pacific population were found entangled in fishing gear (Angliss and Lodge. 2004). In 1996, a vessel from the Pacific Missile Range Facility in Hawaii rescued an entangled humpback, removing two crabpot floats from the whale. A photography study of humpback whales in southeastern Alaska in 2003 and 2004 found at least 53% of individuals showed some kind of scarring from fishing gear entanglement (Neilson et al. 2005). Between 30 and 40% of humpback whales in the Arabian Sea show scarring from entanglements, with fishing effort on the rise (Baldwin et al. 2010).

Alava et al. (2012) reported that 0.53% of humpback whale populations breeding along Ecuador are bycaught annually in commercial fishing gear (mortality of 15-33 individuals per year).

More humpback whales are killed in collisions with ships than any other whale species except fin whales (Jensen and Silber 2003). On the Pacific coast, a humpback whale is killed about every other year by ship strikes (Barlow et al. 1997). Organochlorines, including PCB and DDT, have been identified from humpback whale blubber (Gauthier et al. 1997b). Higher PCB levels have been observed in Atlantic waters versus Pacific waters along the United States and levels tend to increase with individual age (Elfes et al. 2010). Although humpback whales in the Gulf of Maine and off Southern California tend to have the highest PCB concentrations, overall levels are on par with other baleen whales, which are generally lower than odontocete cetaceans (Elfes et al. 2010). As with blue whales, these contaminants are transferred to young through the placenta, leaving newborns with contaminant loads equal to that of mothers before bioaccumulating additional contaminants during life and passing the additional burden to the next generation (Metcalfe et al. 2004). Contaminant levels are relatively high in humpback whales as compared to blue whales. Humpback whales feed higher on the food chain, where prey carry higher contaminant loads than the krill that blue whales feed on.

4.4.4 North Atlantic Right Whale

4.4.4.1 *Population*

All North Atlantic right whales compose a single population. Although not all individuals undergo the same migratory pattern, no subpopulation structuring has been identified.

4.4.4.2 *Distribution*

Right whales occur in sub-polar to temperate waters in all major ocean basins in the world, with a clear migratory pattern of high latitudes in summer and lower latitudes in winter (Cummings 1985; Perry et al. 1999; Rice 1998b). The historical range of North Atlantic right whales extended as far south as Florida and northwestern Africa, and as far north as Labrador, southern Greenland, Iceland, and Norway (Cummings 1985; Reeves et al. 1978; Rice 1998b). Most sightings in the western North Atlantic are concentrated within five primary habitats or high-use areas: coastal waters of the southeastern U.S., Cape Cod and Massachusetts Bays, the Great South Channel, the Bay of Fundy, and the Scotian Shelf (Winn et al. 1986). In 1994, the first three of these areas were designated as critical habitat for the North Atlantic right whale.

North Atlantic right whales have been observed from the mid-Atlantic Bight northward through the Gulf of Maine year-round, but are primarily found along the northeast U.S. during summer and Florida during winter, with migratory routes in between. In New England, peak abundance of North Atlantic right whales in feeding areas occurs in Cape Cod Bay beginning in late winter. In early spring (Late February to April), peak North Atlantic right whale abundance occurs in Jordan and Wilkinson basins to the Great South Channel (Kenney et al. 1995; Nichols et al. 2008; Pace III and Merrick 2008). In late June and July, North Atlantic right whale distribution gradually shifts to the northern edge of Georges Bank. In late summer (August) and fall, much of the population is found in waters in the Bay of Fundy, the western Gulf of Maine and around Roseway Basin (Kenney et al. 2001; Kenney et al. 1995; Pace III and Merrick 2008; Winn et al. 1986). However, year-to-year variation in space and time are known and likely result from patchy prey distribution (Nichols et al. 2008). Variation in the abundance and development of suitable food patches appears to modify the general patterns of movement by reducing peak numbers, stay durations and specific locales (Brown et al. 2001; Kenney 2001). In particular, large changes in the typical pattern of food abundance will dramatically change the general pattern of North Atlantic right whale habitat use (Kenney 2001).

4.4.4.3 ***Migration and Movement***

North Atlantic right whales exhibit extensive migratory patterns, traveling along the eastern seaboard of the U.S. and Canada between calving grounds off Georgia and Florida to northern feeding areas off of the northeast U.S. and Canada in March/April and the reverse direction in November/December. The longest tracking of a North Atlantic right whale was a migration of 1,200 miles in 23 days the Bay of Fundy to Georgia (Mate and Baumgartner 2001). Migrations are typically within 30 nautical miles of the coastline and in waters less than 160 feet deep. Although this pattern is well-known, most of the population, particularly the males and non-pregnant females, is not found in the calving area and may not follow this pattern. Systematic surveys off North Carolina during the winters of 2001 and 2002 sighted eight calves, suggesting the calving grounds may extend as far north as Cape Fear. The few published records from the Gulf of Mexico (Chen et al. 2013; Moore and Clark 1963; Schmidly et al. 1972) represent either distributional anomalies, normal wanderings of occasional animals, or a more extensive historic range beyond the sole known calving and wintering ground in the waters of the southeastern United States. It is unknown where the majority of the non-calving population spends the winter.

There have been a few recent sightings of North Atlantic right whales far offshore, including those from Dutch ships indicating some individuals occur between 40° and 50° N, in waters influenced by the North Atlantic Current (the broad, eastward-flowing extension of the Gulf Stream)(Baumgartner and Mate 2005; Mate et al. 1997b). Right whales have been sighted offshore (greater than 30 miles) during surveys flown off the coast of northeastern Florida and southeastern Georgia from 1996 to 2001. These include three sightings in 1996, one in 1997, 13 in 1998, six in 1999, 11 in 2000, and six in 2001 (within each year, some were repeat sightings). Mate et al. (1997a) recorded radio-tagged animals making extensive movements from the Gulf of Maine into deeper waters off the continental shelf (Mate et al. 1997a). The frequency with which North Atlantic right whales occur in offshore waters in the southeastern U.S. remains unclear. Occasionally, individuals are observed in distant locations, including the Gulf of Mexico, Bermuda, the Gulf of St. Lawrence, Newfoundland, Greenland, Iceland, and northern Norway (an area known as a historical North Atlantic right whale feeding area Smith et al. 2006). The Norwegian sighting (September 1992) represents one of only two sightings this century of a right whale in Norwegian waters, and the first since 1926. Together, these long-range matches indicate an extended range for at least some individuals and perhaps the existence of important habitat areas not presently well described.

4.4.4.4 ***Reproduction and Demography***

Data through the 1990s suggests that mean calving interval increased since 1992 from 3.67 years to more than five years, a significant trend that hampers North Atlantic right whale recovery (Best et al. 2001a; Kraus et al. 2007). This reproductive rate was approximately half that reported from studied populations of southern right whales (Best et al. 2001b). This has been attributed to several possible causes, including higher abortion or perinatal losses (Browning et al. 2009). An analysis of the age structure of North Atlantic right whales suggests that the population contains a smaller proportion of juvenile whales than expected, which may reflect lowered recruitment and/or high juvenile mortality (Best et al. 2001a; Hamilton et al. 1998). In addition, it is possible that the apparently low reproductive rate is due in part to unstable age structure or to reproductive senescence on the part of some females. However, knowledge on either factor is poor. Even though investment in calves is high for North Atlantic right whales, an incident of calf exchange (probably accidentally and soon after birth) and subsequent adoption through weaning has been found (Frasier et al. 2010). Although North Atlantic right whales historically separated from their calves within one year, a shift appears to have taken place around 2001 where mothers (particularly less experienced mothers) return to wintering grounds with their yearling at a much greater frequency (71% overall)(Hamilton and Cooper. 2010). The significance of this change is unknown.

Just west of the USWTR, three observations of four individuals were recorded during aerial surveys in 2009 and 2010, including a female that was observed giving birth (Foley et al. 2011). These sightings occurred well outside existing critical habitat and suggest that the calving area may be broader than currently assumed (Foley et al. 2011; Ramsey 2013). Offshore (about 45 km) surveys flown off the coast of northeastern Florida and southeastern Georgia from 1996 to 2001 documented 1 to 13 annual sightings between 1996 and 2001.

4.4.4.5 ***Vocalization and Hearing***

Right whales vocalize to communicate over long distances and for social interaction, including communication apparently informing others of prey path presence (Biedron et al. 2005; Tyson and Nowacek 2005). Vocalization patterns amongst all right whale species are generally similar, with six major call types: scream, gunshot, blow, upcall, warble, and downcall (McDonald and Moore 2002; Parks and Tyack 2005). A large majority of vocalizations occur in the 300-600 Hz range with up- and downsweeping modulations (Vanderlaan et al. 2003). Vocalizations below 200 Hz and above 900 Hz were rare (Vanderlaan et al. 2003). Calls tend to be clustered, with periods of silence between clusters (Vanderlaan et al. 2003). Gunshot bouts last 1.5 hours on average and up to seven hours (Parks et al. 2012a). Blows are associated with ventilation and are generally inaudible underwater (Parks and Clark 2007). Upcalls are 100-400 Hz (Gillespie and Leaper 2001). Gunshots appear to be a largely or exclusively male vocalization (Parks et al. 2005b). Smaller groups vocalize more than larger groups and vocalization is more frequent at night (Matthews et al. 2001). Moans are usually produced within 10 m of the surface (Matthews et al. 2001). Upcalls were detected year-round in Massachusetts Bay except July and August and peaking in April (Mussoline et al. 2012). Individuals remaining in the Gulf of Maine through winter continue to call, showing a strong diel pattern of upcall and gunshot vocalizations from November through January possibly associated with mating (Bort et al. 2011; Morano et al. 2012; Mussoline et al. 2012). Estimated source levels of gunshots in non-surface active groups are 201 dB re 1 μPa p-p (Hotchkin et al. 2011). While in surface active groups, females produce scream calls and males produce upcalls and gunshot calls as threats to other males; calves (at least female calves) produce warble sounds similar top their mothers' screams (Parks et al. 2003; Parks and Tyack 2005). Source levels for these calls in surface active groups range from 137-162 dB rms re: 1 µPa-m, except for gunshots, which are 174-192 dB rms re: 1 µPa-m (Parks and Tyack 2005). Upcalls may also be used to reunite mothers with calves (Parks and Clark 2007). Atlantic right whales shift calling frequencies, particularly of upcalls, as well as increase call amplitude over both long and short term periods due to exposure to vessel noise (Parks and Clark 2007; Parks et al. 2005a; Parks et al. 2007a; Parks et al. 2011a; Parks et al. 2010; Parks et al. 2012b; Parks et al. 2006), particularly the peak frequency (Parks et al. 2009). North Atlantic right whales respond to anthropogenic sound designed to alert whales to vessel presence by surfacing (Nowacek et al. 2003; Nowacek et al. 2004b).

No direct measurements of right whale hearing have been undertaken (Parks and Clark 2007). Models based upon right whale auditory anatomy suggest a hearing range of 10 Hz to 22 kHz (Parks et al. 2007b).

4.4.4.6 *Habitat*

Available evidence from North Atlantic right whale foraging and habitat studies shows that North Atlantic right whales focus foraging activities where physical oceanographic features such as water depth, current, and mixing fronts combine to concentrate copepods (Baumgartner et al. 2003; Mayo and Marx 1990; Murison and Gaskin 1989; Wishner et al. 1988).

4.4.4.7 *Status and Trends*

The Northern right whale was originally listed as endangered in 1970 (35 FR 18319), and this status remained since the inception of the ESA in 1973. The early listing included both the North Atlantic and the North Pacific populations, although subsequent genetic studies conducted by Rosenbaum (2000) resulted in strong evidence that North Atlantic and North Pacific right whales are separate species. Following a comprehensive status review, NMFS concluded that North Atlantic and North Pacific right whales are separate species. In March 2008, NMFS published a final rule listing North Pacific and North Atlantic right whales as separate species (73 FR 12024).

North Atlantic right whales were formerly abundant, with an estimated 5,500 individuals present in the 16th century throughout the North Atlantic (Reeves 2001; Reeves et al. 2007). A review of the photo-id recapture database in June 2006, indicated that only 313 individually recognized North Atlantic right whales were observed during 2001. This represents a nearly complete census, and the estimated minimum population size. However, no estimate of abundance with an associated coefficient of variation has been calculated for the population. Review of the photo-identification recapture database as it existed in July 2010 indicated that 396 individually recognized whales in the catalog were known to be alive during 2007. In 2010, the best estimate of catalogued North Atlantic right whales was 490 individuals (Glover et al. 2013).

The population growth rate reported for the period 1986 to 1992 by Knowlton et al. (1994) was 2.5%, suggesting the stock was showing signs of slow recovery. However, work by Caswell et al. (1999) suggested that crude survival probability declined from about 0.99 in the early 1980's to about 0.94 in the late 1990s. Additional work conducted in 1999 showed that survival had indeed declined in the 1990s, particularly for adult females (Best et al. 2001a). Another workshop in September 2002 further confirmed the decline in this population (Clapham 2002).

4.4.4.8 *Natural Threats*

Several researchers have suggested that the recovery of North Atlantic right whales has been impeded by competition with other whales for food (Rice 1974; Scarff 1986). Mitchell (1975) analyzed trophic interactions among baleen whales in the western North Atlantic and noted that the foraging grounds of North Atlantic right whales overlapped with the foraging grounds of sei whales. Both species feed preferentially on copepods. Reeves et al. (1978) noted that several species of whales feed on copepods in the eastern North Pacific, so that the foraging pattern and success of right whales would be affected by other whales as well. Mitchell (1975) argued that the North Atlantic right whale population had been depleted by several centuries of whaling before steam-driven boats allowed whalers to hunt sei whales; from this, he hypothesized that the decline of the right whale population made more food available to sei whales and helped their population to grow. He then suggested that competition with the sei whale population impedes or prevents the recovery of the right whale population.

Other natural factors influencing right whale recovery are possible, but unquantified. Right whales have been subjects of killer whale attacks and, because of their robust size and slow swimming speed, tend to fight killer whales when confronted (Ford and Reeves 2008). Similarly, mortality or debilitation from disease and red tide events are not known, but have the potential to be significant problems in the recovery of right whales because of their small population size.

4.4.4.9 *Anthropogenic Threats*

Several human activities are known to threaten North Atlantic right whales: whaling, commercial fishing, shipping, and environmental contaminants. Historically, whaling represented the greatest threat to every population of right whales and was ultimately responsible for listing right whales as an endangered species. As its legacy, whaling reduced North Atlantic right whales to about 300 individuals in the western North Atlantic Ocean; the number of North Atlantic right whales in the eastern North Atlantic Ocean is probably much smaller, although we cannot estimate the size of that population from the data available.

As reported in NOAA Technical Memorandum NMFS-OPR-48 (Silber and Bettridge 2012), the greatest known anthropogenic threat to the recovery of the highly depleted North Atlantic right whale (*Eubalaena glacialis*) is at-sea collisions with vessels (Clapham *et al*., 1999; Kraus *et al*., 2005, NMFS, 2005; Knowlton and Brown, 2007). In a population believed to be comprised of 350-550 individuals, any mortality caused by human activity is cause for concern, especially if these threats are preventing the population from recovering from potential extinction. Over the 20-year period from 1986-2005, 50 documented right whale deaths occurred, 19 of which were attributed to vessel strikes (the cause of death could not be determined in the majority of the other of the cases) (Knowlton and Kraus, 2001; Kraus *et al*., 2005; Glass *et al*., 2010). These are likely minimum counts because not all dead whales are detected particularly in offshore waters, and some detected carcasses are never recovered while those that are recovered may be in advanced stages of decomposition that preclude a definitive cause of death determination (Glass *et al*., 2010).

There is no evidence that the number of human-caused right whale deaths has diminished in recent years. An average of about two known North Atlantic right whale deaths and serious injuries from vessel strikes occurred annually in 2004 through 2008 (2008 being the most recent years for which peer-reviewed mortality counts are available) (Glass *et al*., 2010; Waring *et al*., 2010).

Right whales are more likely, per capita, to suffer a vessel strike than any other large whale species (Vanderlaan and Taggart, 2007). The factors contributing to their vulnerability to vessel strikes, although not fully clear, most likely relate to the species' coastal distribution that exposes them to high density vessel traffic, their tendency to spend considerable amounts of time at the surface, and that they tend to exhibit little or no vessel avoidance behavior (Terhune and Verboom, 1999; Nowacek *et al*., 2004). Avoiding an advancing ship, even if it was perceived as a threat (and there is no evidence for this), is not likely an inherent behavioral response for right whales (Ford and Reeves, 2008).

The endangered status of the right whale and the magnitude of vessel-strike threat to the species in the Northwest Atlantic Ocean has prompted the National Oceanic and Atmospheric Administration (NOAA) to develop and implement a number of management actions to reduce this threat (Bettridge and Silber, 2008; Silber *et al*., submitted). Among these actions were mandatory or recommended changes in vessel-routing practices (Silber *et al*., submitted), and mandatory or recommended vessel speed restrictions (NMFS, 2004; NMFS, 2008). In particular, NOAA instituted regulations that restrict vessel speeds in certain areas and at certain times along the U.S eastern seaboard where right whales feed, migrate, socialize, and rear their young (NMFS, 2008).

The U.S. National Marine Fisheries Service's (NMFS) Final Rule to reduce the severity and likelihood of vessel strikes to North Atlantic right whales went into effect on 9 December 2008 (73 FR 60173; 10 October 2008). The stated goal of the rule was "*to reduce or eliminate the threat of ship strikes [of North Atlantic right whales] - the primary source of mortality in the endangered population*." It requires that vessels 65 feet and greater in length travel at speeds of 10 knots or less near several key port entrances and in certain areas of right whale aggregation and along the U.S. eastern seaboard, known as "Seasonal Management Areas" (SMA). These SMAs are in effect during certain times of the year that correspond to right whale seasonal movement and aggregation patterns.

Concern also exists over climate change and its effect on the ability of North Atlantic right whales to recover (Greene et al. 2003b). Specifically, the variations in oceanography resulting from current shifts and water temperatures can significantly affect the occurrence of the North Atlantic right whale's primary food, copepod crustaceans. If climate changes such that current feeding areas cannot sustain North Atlantic right whales, the population may have to shift to reflect changes in prey distribution, pursue other prey types, or face prey shortage. Changes in calving intervals with sea surface temperature have already been documented for southern right whales (Leaper et al. 2006).

North Atlantic right whales, as with many marine mammals, are exposed to numerous toxins in their environment, many of which are introduced by humans. Levels of chromium in North Atlantic right whale tissues are sufficient to be mutagenic and cause cell death in lung, skin, or testicular cells and are a concern for North Atlantic right whale recovery (Chen et al. 2009; Wise et al. 2008). The organochlorines DDT, DDE, PCBs, dieldrin, chlordane, HCB, and heptachlor epoxide have been isolated from blubber samples and reported concentrations may underestimate actual levels (Woodley et al. 1991). Mean PCB levels in North Atlantic right whales are greater than any other baleen whale species thus far measured, although less than one-quarter of the levels measured in harbor porpoises (Gauthier et al. 1997a; Van Scheppingen et al. 1996). Organochlorines and pesticides, although variable in concentration by season, do not appear to currently threaten North Atlantic right whale health and recovery (Weisbrod et al. 2000). Flame retardants such as PBDEs (known to be carcinogenic) have also been measured in North Atlantic right whales (Montie et al. 2010).

4.4.4.10 ***Critical Habitat***

Critical habitat is designated for right whales in the North Atlantic. NMFS designated three areas in June 1994 as critical habitat for *Eubalaena glacialis* for feeding and calving (59 FR 28805). The critical habitats for feeding cover portions of the Great South Channel (east of Cape Cod), Massachusetts Bay and Cape Cod Bay, and Stellwagen Bank. Northern critical habitat was designated because of the concentration of right whales that feed in the area, apparently associated with complex oceanographic features that drive prey density and distribution. This area has come under considerable scrutiny within the past few years because of the concern over ship strikes in this area. Boston serves as a major port facility and vessels transiting to and from the port cross critical habitat where North Atlantic right whale mortality occurs. Shipping traffic has generally increased in the recent past and could be considered to degrade the habitat due to the additional mortality and injury risk now present in the area.

Five areas have been reported to be critical to the survival and recovery of North Atlantic right whales: (1) coastal Florida and Georgia; (2) the Great South Channel, which lies east of Cape Cod; (3) Cape Cod and Massachusetts Bays; (4) the Bay of Fundy; and (5) Browns and Baccaro Banks off southern Nova Scotia. The first three areas occur in U.S. waters and have been designated by NMFS as critical habitat (59 FR 28793). North Atlantic right whales are most abundant in Cape Cod Bay between February and April (Hamilton and Mayo 1990; Schevill et al. 1986; Watkins and Schevill 1982), in the Great South Channel in May and June (Kenney et al. 1986; Payne et al. 1990a), and off Georgia/Florida from mid-November through March (Slay *et al.* 1996). Right whales also frequent the Bay of Fundy, Browns and Baccaro Banks (in Canadian waters), Stellwagen Bank and Jeffrey’s Ledge in spring and summer months and use mid-Atlantic waters as a migratory pathway between winter calving grounds and their spring and summer nursery/feeding areas in the Gulf of Maine. A recent review and comparison of sighting data suggests that Jeffrey’s Ledge may also be regularly used by right whales in late fall (October through December)(Weinrich et al. 2000).

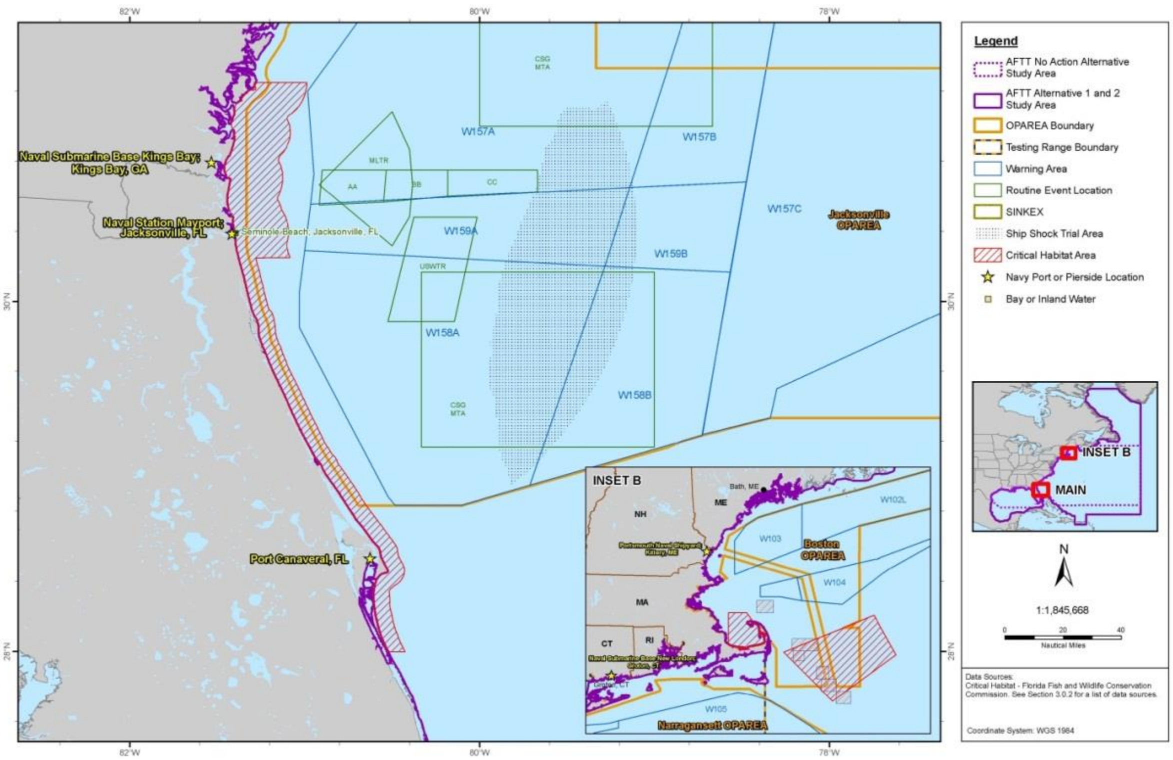

Figure 10. Designated Critical Habitat for North Atlantic Right Whale in the AFTT Study Area

The availability of dense concentrations of zooplankton blooms in Cape Cod Bay in late winter and the Great South Channel in spring is described as the key factor for right whale utilization of these areas. Kraus and Kenney (1991) provide an overview of data regarding right whale use of these areas. Important habitat components in Cape Cod Bay include seasonal availability of dense zooplankton patches and protection from weather afforded by land masses surrounding the bay. The spring current regime and bottom topography of the Great South Channel result in nutrient rich upwelling conditions. These conditions support the dense plankton and zooplankton blooms utilized by right whales. The combination of highly oxygenated water and dense zooplankton concentrations are optimal conditions for the small schooling fishes (sand lance, herring and mackerel) that prey upon some of the same zooplankton as right whales. Therefore, the abundance of these fishes, in turn, may affect and be affected by the distribution of several piscivorous marine mammal species such as humpback, fin, minke, and pilot whales, Atlantic whitesided dolphins, and harbor porpoise (CETAP 1982a).

Overfishing has severely reduced the stocks of several groundfish species such as cod, haddock, and yellowtail flounder. Recovery of commercially targeted finfish stocks from their current overfished condition may reduce the biomass of small schooling fish that feed directly on zooplankton resources throughout the region. It is unknown whether zooplankton densities that occur seasonally in Cape Cod Bay or the Great South Channel could be expected to increase significantly. However, increased predation by groundfish on small schooling fish in certain areas and at specific critical periods may allow the necessary high zooplankton densities to be maintained in these areas for longer periods, or accumulate in other areas at levels acceptable to right whales.

Fishing is allowed within the Cape Cod Bay and Great South Channel right whale critical habitat. Lobster trap gear and anchored gillnet gear are believed to pose the most serious risks of entanglement and serious injury to right whales frequenting these waters. As a result, regulations developed under the Atlantic Large Whale Take Reduction Plan restrict the use of lobster and anchored gillnet gear in Cape Cod Bay and Great South Channel critical habitat. The most restrictive measures apply during peak right whale abundance: January 1 to May 15 in Cape Cod Bay, and 1 April to 30 June in the Great South Channel critical habitat. Measures include prohibitions on the use of lobster trap gear and anchored gillnet gear in the Great South Channel critical habitat during periods of peak right whale abundance (with the exception of gillnet gear in the Great South Channel Sliver Area), and, for Cape Cod Bay critical habitat, anchored gillnet gear prohibitions and lobster trap restrictions during peak right whale abundance. During non-peak periods of right whale abundance, lobster trap and gillnet fishers must modify their gear by using weak links in net and/or buoy lines, follow gillnet anchoring requirements and meet mandatory breaking strengths for buoy line weak links, amongst others. Additional measures (i.e., gear marking requirements, and prohibitions on the use of floating line and the wet storage of gear) apply within as well as outside of critical habitat. All of these measures are intended to reduce the likelihood of whale entanglements or the severity of an entanglement should an animal encounter anchored gillnet or lobster gear.

The critical habitat identified in the Southeast U.S. is used primarily as a calving and nursery area. The nearshore waters of northeast Florida and southern Georgia were formally designated as critical habitat for right whales on 3 June 1994 (59 FR 28793); ten years after they were first identified as a likely calving and nursery area for right whales. Since that time, 74 percent of all known, mature female North Atlantic right whales have been documented in this area (Kraus et al. 1993). While sightings off Georgia and Florida include primarily adult females and calves, juveniles and adult males have also been observed.

4.4.5 **Sei Whale**

4.4.5.1 ***Population Designations***

The population structure of sei whales is unknown and populations herein assume (based upon migratory patterns) population structuring is discrete by ocean basin (north and south), except for sei whales in the Southern Ocean, which may form a ubiquitous population or several discrete ones.

4.4.5.2 ***North Atlantic***

In the western North Atlantic, a major portion of the sei whale population occurs in northern waters, potentially including the Scotian Shelf, along Labrador and Nova Scotia, south into the U.S. EEZ, including the Gulf of Maine and Georges Bank (Mitchell and Chapman 1977; Waring et al. 2004). These whales summer in northern areas (such as Labrador and Nova Scotia) before migrating south to waters along Florida, in the Gulf of Mexico, and the northern Caribbean Sea (Gambell 1985c; Mead 1977). Sei whales may range as far south as North Carolina. In the U.S. EEZ, the greatest abundance occurs during spring, with most sightings on the eastern edge of

Georges Bank, in the Northeast Channel, and in Hydrographer Canyon (CETAP 1982b). In 1999, 2000, and 2001, the NMFS aerial surveys found sei whales concentrated along the northern edge of Georges Bank during spring (Waring et al. 2004). Surveys in 2001 found sei whales south of Nantucket along the continental shelf edge (Waring et al. 2004). During years of greater prey abundance (e.g., copepods), sei whales are found in more inshore waters, such as the Great South Channel (1987 and 1989), Stellwagen Bank (1986), and the Gulf of Maine (Payne et al. 1990b; Schilling et al. 1992). In the eastern Atlantic, sei whales occur in the Norwegian Sea, occasionally occurring as far north as Spitsbergen Island, and migrate south to Spain, Portugal, and northwest Africa (Gambell 1985c; Jonsgård and Darling 1977).

In the action area, sei whales occur in the open ocean (Labrador Current, North Atlantic Gyre, and Gulf Stream) between 10° and 70° N and rarely near the coast (Horwood 2009; Jefferson et al. 2008). Sei whales feed and migrate east to west across large sections of the North Atlantic, although not in equatorial waters (Olsen et al. 2009). While feeding, most of the Nova Scotia sei whale stock is centered in northerly waters of the Scotian Shelf (Waring et al. 2010). Sei whales may occur in northern east coast waters during the spring and summer, including the Gulf of Maine and Georges Bank but also the Bay of Fundy. High concentrations are often observed along the northern flank, eastern tip, and southern shelf break of Georges Bank. During fall, sei whales may be found in limited shelf areas of the Northeast Channel and in the western Gulf of Maine (CETAP 1982a; Stimpert et al. 2003). Spring is the period of greatest abundance in Georges Bank and into the Northeast Channel area, along the Hydrographer Canyon (CETAP 1982a; Waring et al. 2010).

4.4.5.3 *Movement*

The migratory pattern of this species is thought to encompass long distances from high-latitude feeding areas in summer to low-latitude breeding areas in winter; however, the location of winter areas remains largely unknown (Perry et al. 1999). Sei whales are often associated with deeper waters and areas along continental shelf edges (Hain et al. 1985). This general offshore pattern is disrupted during occasional incursions into shallower inshore waters (Waring et al. 2004). The species appears to lack a well-defined social structure and individuals are usually found alone or in small groups of up to six whales (Perry et al. 1999). When on feeding grounds, larger groupings have been observed (Gambell 1985c).

4.4.5.4 *Reproduction*

Very little is known regarding sei whale reproduction. Reproductive activities for sei whales occur primarily in winter. Gestation is about 12.7 months, calves are weaned at 6-9 months, and the calving interval is about 2-3 years (Gambell 1985c; Rice 1977). Sei whales become sexually mature at about age 10 (Rice 1977). Of 32 adult female sei whales harvested by Japanese whalers, 28 were found to be pregnant while one was pregnant and lactating during May-July 2009 cruises in the western North Pacific (Tamura et al. 2009).

4.4.5.5 *Vocalization and Hearing*

Data on sei whale vocal behavior is limited, but includes records off the Antarctic Peninsula of broadband sounds in the 100-600 Hz range with 1.5 s duration and tonal and upsweep calls in the 200-600 Hz range of 1-3 s durations (McDonald et al. 2005). Differences may exist in vocalizations between ocean basins (Rankin and Barlow 2007a). The first variation consisted of sweeps from 100 Hz to 44 Hz, over 1.0 seconds. During visual and acoustic surveys conducted in the Hawaiian Islands in 2002, Rankin and Barlow (2007b) recorded 107 sei whale vocalizations, which they classified as two variations of low-frequency downswept calls. The second variation, which was more common (105 out of 107) consisted of low frequency calls which swept from 39 Hz to 21 Hz over 1.3 seconds. These vocalizations are different from sounds attributed to sei whales in the Atlantic and Southern Oceans but are similar to sounds that had previously been attributed to fin whales in Hawaiian waters. Vocalizations from the North Atlantic consisted of paired sequences (0.5-0.8 s, separated by 0.4-1.0 s) of 10-20 short (4 ms) FM sweeps between 1.5-3.5 kHz (Thomson and Richardson 1995).

4.4.5.6 ***Status and Trends***

The sei whale was originally listed as endangered in 1970 (35 FR 18319), and this status remained since the inception of the ESA in 1973. Consideration of the status of populations outside of the action area is important under the present analysis to determine how the risk to the affected population(s) bears on the status of the species as a whole. Table 34 provides estimates of historic and current abundance for ocean regions.

Table 34. Summary of past and present sei whale abundance.

Region	Population, stock, or study area	Pre-exploitation estimate	95% CI	Recent estimate	95% CI	Source
Global	--	>105,000	--	25,000	--	(Braham 1991)
North Atlantic	Basinwide	--	--	>4000	--	(Braham 1991)
	NMFS-Nova Scotia stock	--	--	207	--	(NMFS 2008a)
	IWC-Iceland-Denmark stock	--	--	1,290	0-2,815*	(Cattanach et al. 1993)
	IWC-Iceland-Denmark stock	--	--	1,590	343-2,837*	(Cattanach et al. 1993)
North Pacific	Basinwide	42,000	--	7,260-12,620*	--	(Tillman 1977); *circa 1974
	NMFS-eastern North Pacific stock	--	--	46	CV=0.61	(Carretta et al. 2008)
	NMFS-Hawaii stock	--	--	77	0-237*	(Carretta et al. 2008)
Southern Hemisphere	Basinwide	63,100	--	--	--	(Mizroch et al. 1984)
	Basinwide	65,000	--	--	--	(Braham 1991)
	South of 60°S	--	--	626	553-699	(IWC 1996)
	South of 30°S	--	--	9,718	--	(IWC 1996)

***Note: Confidence Intervals (C.I.) not provided by the authors were calculated from Coefficients of Variation (C.V.) where available, using the computation from Gotelli and Ellison (2004).**

4.4.5.7 *North Atlantic*

No information on sei whale abundance exists prior to commercial whaling (Perry et al. 1999). Between 1966 and 1972, whalers from land stations on the east coast of Nova Scotia engaged in extensive hunts of sei whales on the Nova Scotia shelf, killing about 825 individuals (Mitchell and Chapman 1977). In 1974, the North Atlantic stock was estimated to number about 2,078 individuals, including 965 whales in the Labrador Sea group and 870 whales in the Nova Scotia group (Mitchell and Chapman 1977). In the northwest Atlantic, Mitchell and Chapman (1977) estimated the Nova Scotia stock to contain 1,393-2,248 whales; an aerial survey program conducted from 1978 to 1982 on the continental shelf and edge between Cape Hatteras, North Carolina, and Nova Scotia generated an estimate of 280 sei whales (CETAP 1982b). These two estimates are more than 20 years out of date and likely do not reflect the current true abundance; in addition, the CETAP estimate has a high degree of uncertainty and is considered statistically unreliable (Perry et al. 1999; Waring et al. 2004; Waring et al. 1999). The total number of sei whales in the U.S. Atlantic EEZ remains unknown (Waring et al. 2006). Rice (1977) estimated total annual mortality for adult females as 0.088 and adult males as 0.103.

4.4.5.8 *Natural Threats*

Andrews (1916) suggested that killer whales attacked sei whales less frequently than fin and blue whales in the same areas. Sei whales engage in a flight responses to evade killer whales, which involves high energetic output, but show little resistance if overtaken (Ford and Reeves 2008). Endoparasitic helminths (worms) are commonly found in sei whales and can result in pathogenic effects when infestations occur in the liver and kidneys (Rice 1977).

4.4.5.9 *Anthropogenic Threats*

Human activities known to threaten sei whales include whaling, commercial fishing, and maritime vessel traffic. Historically, whaling represented the greatest threat to every population of sei whales and was ultimately responsible for listing sei whales as an endangered species. Sei whales are thought to not be widely hunted, although harvest for scientific whaling or illegal harvesting may occur in some areas. In 2009, 100 sei whales were killed during western North Pacific surveys (Bando et al. 2010).

Sei whales are known to accumulate DDT, DDE, and PCBs (Borrell 1993; Borrell and Aguilar 1987; Henry and Best 1983). Males carry larger burdens than females, as gestation and lactation transfer these toxins from mother to offspring.

4.4.6 **Sperm Whale**

4.4.6.1 *Populations*

There is no clear understanding of the global population structure of sperm whales (Dufault et al. 1999). Recent ocean-wide genetic studies indicate low, but statistically significant, genetic diversity and no clear geographic structure, but strong differentiation between social groups (Lyrholm and Gyllensten 1998; Lyrholm et al. 1996; Lyrholm et al. 1999). However, vocal dialects indicate parent-offspring transmission that indicates differentiation in populations (Rendell et al. 2011). The IWC currently recognizes four sperm whale stocks: North Atlantic, North Pacific, northern Indian Ocean, and Southern Hemisphere (Dufault et al. 1999; Reeves and Whitehead 1997). The NMFS recognizes six stocks under the MMPA- three in the Atlantic/Gulf of Mexico and three in the Pacific (Alaska, California-Oregon-Washington, and Hawaii; (Perry et al. 1999; Waring et al. 2004). Genetic studies indicate that movements of both sexes through expanses of ocean basins are common, and that males, but not females, often breed in different ocean basins than the ones in which they were born (Whitehead 2003a). Sperm whale populations appear to be structured socially, at the level of the clan, rather than geographically (Whitehead 2003a; Whitehead et al. 2008).

4.4.6.2 ***North Atlantic***

In the western North Atlantic, sperm whales range from Greenland south into the Gulf of Mexico and the Caribbean, where they are common, especially in deep basins off of the continental shelf (Romero et al. 2001; Wardle et al. 2001). The northern distributional limit of female/immature pods is probably around Georges Bank or the Nova Scotian shelf (Whitehead et al. 1991). Seasonal aerial surveys confirm that sperm whales are present in the northern Gulf of Mexico in all seasons (Hansen et al. 1996a; Mullin et al. 1994a). Sperm whales distribution follows a distinct seasonal cycle, concentrating east-northeast of Cape Hatteras in winter and shifting northward in spring when whales are found throughout the Mid-Atlantic Bight. Distribution extends further northward to areas north of Georges Bank and the Northeast Channel region in summer and then south of New England in fall, back to the Mid-Atlantic Bight. In the eastern Atlantic, mature male sperm whales have been recorded as far north as Spitsbergen (Øien 1990). Recent observations of sperm whales and stranding events involving sperm whales from the eastern North Atlantic suggest that solitary and paired mature males predominantly occur in waters off Iceland, the Faroe Islands, and the Norwegian Sea (Christensen et al. 1992a; Christensen et al. 1992b; Gunnlaugsson and Sigurjónsson 1990; Øien 1990).

4.4.6.3 ***Movement***

Mature males range between 70º N in the North Atlantic and 70º S in the Southern Ocean (Perry et al. 1999; Reeves and Whitehead 1997), whereas mature females and immature individuals of both sexes are seldom found higher than 50º N or S (Reeves and Whitehead 1997). In winter, sperm whales migrate closer to equatorial waters (Kasuya and Miyashita 1988; Waring et al. 1993) where adult males join them to breed. Movement patterns of Pacific female and immature male groups appear to follow prey distribution and, although not random, movements are difficult to anticipate and are likely associated with feeding success, perception of the environment, and memory of optimal foraging areas (Whitehead et al. 2008). However, no sperm whale in the Pacific has been known to travel to points over 5,000 km apart and only rarely have been known to move over 4,000 km within a time frame of several years. This means that although sperm whales do not appear to cross from eastern to western sides of the Pacific (or vice-versa), significant mixing occurs that can maintain genetic exchange. Movements of several hundred kilometers are common, (i.e. between the Galapagos Islands and the Pacific coastal Americas). Movements appear to be group or clan specific, with some groups traveling straighter courses than others over the course of several days. However, general transit speed averages about 4 km/h. Sperm whales in the Caribbean region appear to be much more restricted in their movements, with individuals repeatedly sighted within less than 160 km of previous sightings.

4.4.6.4 *Habitat*

Sperm whales have a strong preference for waters deeper than 1,000 m (Reeves and Whitehead 1997; Watkins 1977), although Berzin (1971) reported that they are restricted to waters deeper than 300 m. While deep water is their typical habitat, sperm whales are rarely found in waters less than 300 m in depth (Clarke 1956b; Rice 1989b). Sperm whales have been observed near Long Island, New York, in water between 40-55 m deep (Scott and Sadove 1997). When they are found relatively close to shore, sperm whales are usually associated with sharp increases in topography where upwelling occurs and biological production is high, implying the presence of a good food supply (Clarke 1956b). Such areas include oceanic islands and along the outer continental shelf.

Sperm whales are frequently found in locations of high productivity due to upwelling or steep underwater topography, such as continental slopes, seamounts, or canyon features (Jaquet and Whitehead 1996; Jaquet et al. 1996). Cold-core eddy features are also attractive to sperm whales in the Gulf of Mexico, likely because of the large numbers of squid that are drawn to the high concentrations of plankton associated with these features (Biggs et al. 2000; Davis et al. 2000c; Davis et al. 2000d; Davis et al. 2000e; Davis et al. 2002; Wormuth et al. 2000). Surface waters with sharp horizontal thermal gradients, such as along the Gulf Stream in the Atlantic, may also be temporary feeding areas for sperm whales (Griffin 1999; Jaquet et al. 1996; Waring et al. 1993). Sperm whales over George’s Bank were associated with surface temperatures of 23.2-24.9° C (Waring et al. 2003).

Local information is inconsistent regarding some aspects of sperm whale habitat utilization. Gregr and Trites (2001) reported that female sperm whales off British Columbia were relatively unaffected by the surrounding oceanography. However, Tynan et al. (2005) reported increased sperm whales densities with strong turbulence-associated topographic features along the continental slope near Heceta Bank.

Sperm whale occurrence varies within the action area. High sperm whale densities were found in the Grand Banks of Newfoundland (NMFS 2006c; Palka 2006). During late spring and throughout the summer, sperm whales occur over the southern Scotian Shelf in waters less than 100 m deep (NMFS 2006c; Palka 2006). High winter density is found in inner slope waters east and northeast of Cape Hatteras and then shifts northward to Delaware, Virginia, and the southern portion of Georges Bank (NMFS 2006c; Palka 2006; Waring et al. 2010).

Sperm whales are the most common large whale in the northern Gulf of Mexico, with particularly high concentrations at the mouth of the Mississippi River and along the continental slope in or near cyclonic cold-core eddies due to enhanced productivity here (Davis et al. 2007; O'Hern and Biggs. 2009; Palka and Johnson 2007). However, they may be found throughout the northern Gulf of Mexico year-round (Fulling et al. 2003; Hansen et al. 1996b; Maze-Foley and Mullin 2006; Mullin and Fulling 2004; Mullin and Hoggard 2000; Mullin et al. 2004b; Mullin et al. 1994b). Southern Gulf of Mexico occurrence, abundance, and habitat use are poorly known, but sperm whales are at least present in continental slope waters of the western Bay of Campeche (Ortega Ortiz 2002). Sperm whales also occur in waters surrounding Puerto Rico and the U.S. Virgin Islands (Roden and Mullin 2000; Swartz and Burks 2000; Swartz et al. 2002). Mignucci-

Giannoni (1988) suggested sperm whales occur from late fall through winter and early spring but are rare from April to September around Puerto Rico. Strandings here are relatively common (Mignucci-Giannoni et al. 1999).

4.4.6.5 ***Reproduction***

Female sperm whales become sexually mature at an average of 9 years or 8.25-8.8 m (Kasuya 1991). Males reach a length of 10 to 12 m at sexual maturity and take 9-20 years to become sexually mature, but require another 10 years to become large enough to successfully breed (Kasuya 1991; Würsig et al. 2000a). Mean age at physical maturity is 45 years for males and 30 years for females (Waring et al. 2004). Adult females give birth after roughly 15 months of gestation and nurse their calves for 2-3 years (Waring et al. 2004). The calving interval is estimated to be every 4-6 years between the ages of 12 and 40 (Kasuya 1991; Whitehead et al. 2008). In the North Pacific, female sperm whales and their calves are usually found in tropical and temperate waters year round, while it is generally understood that males move north in the summer to feed in the Gulf of Alaska, Bering Sea, and waters off of the Aleutian Islands (Kasuya and Miyashita 1988). It has been suggested that some mature males may not migrate to breeding grounds annually during winter, and instead may remain in higher latitude feeding grounds for more than 1 year at a time (Whitehead and Arnbom 1987).

Sperm whale age distribution is unknown, but sperm whales are believed to live at least 60 years (Rice 1978). Estimated annual mortality rates of sperm whales are thought to vary by age, but previous estimates of mortality rate for juveniles and adults are now considered unreliable (IWC 1980). In addition to anthropogenic threats, there is evidence that sperm whale age classes are subject to predation by killer whales (Arnbom et al. 1987; Pitman et al. 2001).

Stable, long-term associations among females form the core of sperm whale societies (Christal et al. 1998). Up to about a dozen females usually live in such groups, accompanied by their female and young male offspring. Young individuals are subject to alloparental care by members of either sex and may be suckled by non-maternal individuals (Gero et al. 2009). Group sizes may be smaller overall in the Caribbean Sea (6-12 individuals) versus the Pacific (25-30 individuals)(Jaquet and Gendron 2009). Groups may be stable for long periods, such as for 80 days in the Gulf of California (Jaquet and Gendron 2009). Males start leaving these family groups at about 6 years of age, after which they live in "bachelor schools," but this may occur more than a decade later (Pinela et al. 2009). The cohesion among males within a bachelor school declines with age. During their breeding prime and old age, male sperm whales are essentially solitary (Christal and Whitehead 1997).

4.4.6.6 ***Vocalization and Hearing***

Sound production and reception by sperm whales are better understood than in most cetaceans. Sperm whales produce broad-band clicks in the frequency range of 100 Hz to 20 kHz that can be extremely loud for a biological source (200-236 dB re 1μPa), although lower source level energy has been suggested at around 171 dB re 1 μPa (Goold and Jones 1995; Møhl et al. 2003; Weilgart and Whitehead 1993a; Weilgart and Whitehead 1997). Most of the energy in sperm whale clicks is concentrated at around 2-4 kHz and 10-16 kHz (Goold and Jones 1995; NMFS 2006d; Weilgart and Whitehead 1993a). The highly asymmetric head anatomy of sperm whales is likely an adaptation to produce the unique clicks recorded from these animals (Cranford 1992; Norris and Harvey 1972; Norris and Harvey. 1972). Long, repeated clicks are associated with feeding and echolocation (Goold and Jones 1995; Weilgart and Whitehead 1993a; Weilgart and Whitehead 1997). However, clicks are also used in short patterns (codas) during social behavior and intragroup interactions (Weilgart and Whitehead 1993a). They may also aid in intra-specific communication. Another class of sound, “squeals”, are produced with frequencies of 100 Hz to 20 kHz (e.g., Weir et al. 2007).

Our understanding of sperm whale hearing stems largely from the sounds they produce. The only direct measurement of hearing was from a young stranded individual from which auditory evoked potentials were recorded (Carder and Ridgway 1990). From this whale, responses support a hearing range of 2.5-60 kHz. However, behavioral responses of adult, free-ranging individuals also provide insight into hearing range; sperm whales have been observed to frequently stop echolocating in the presence of underwater pulses made by echosounders and submarine sonar (Watkins et al. 1985; Watkins and Schevill 1975b). They also stop vocalizing for brief periods when codas are being produced by other individuals, perhaps because they can hear better when not vocalizing themselves (Goold and Jones 1995). Because they spend large amounts of time at depth and use low-frequency sound, sperm whales are likely to be susceptible to low frequency sound in the ocean (Croll et al. 1999a).

4.4.6.7 *Status and Trends*

Sperm whales were originally listed as endangered in 1970 (35 FR 18319), and this status remained with the inception of the ESA in 1973. Although population structure of sperm whales is unknown, several studies and estimates of abundance are available. Consideration of the status of populations outside of the action area is important under the present analysis to determine the risk to the affected population(s) bears on the status of the species as a whole. Table 35 contains historic and current estimates of sperm whales by region. Sperm whale populations probably are undergoing the dynamics of small population sizes, which is a threat in and of itself. In particular, the loss of sperm whales to directed Soviet whaling likely inhibits recovery due to the loss of adult females and their calves, leaving sizeable gaps in demographic and age structuring (Whitehead 2003a).

Table 35. Summary of past and present sperm whale abundance.

Region	Population, stock, or study area	Pre-exploitation estimate	95% CI	Recent estimate	95% CI	Source
Global	~~	~~	~~	900,000	~~	(Würsig et al. 2000a)
	~~	1,110,000	672,000-1,512,000	360,000	105,984-614,016*	(Whitehead 2002)
North Atlantic	Basinwide-females	224,800	~~	22,000	~~	(Gosho et al. 1984; Würsig et al. 2000a)
	Northeast Atlantic, Faroes, Iceland, and U.S.	~~	~~	13,190	~~	(Whitehead 2002)

	East coast					
	NMFS-North Atlantic stock	>4,685*	~~	4,804	1,226-8,382*	(NMFS 2008a)
	Iceland	~~	~~	1,234	823-1,645*	(Gunnlaugsson and Sigurjónsson 1990)
	Faroe Islands	~~	~~	308	79-537*	(Gunnlaugsson and Sigurjónsson 1990)
	Norweign Sea	~~	~~	5,231	2,053-8,409*	(Christensen et al. 1992b)
	Northern Norway to Spitsbergen	15,000	~~	2,548	1,200-3,896*	(Øien 1990)
Gulf of Mexico	NMFS-Gulf of Mexico stock	~~	~~	1,665	CV=0.2	(NMFS 2008a)
	Off Mississippi River Delta	~~	~~	398	253-607	(Jochens et al. 2006)
	North-central and northwestern Gulf of Mexico	~~	~~	87	52-146	(Mullin et al. 2004a)
North Pacific	Basinwide	620,400	~~	472,100	~~	(Gosho et al. 1984)
	Basinwide	~~	~~	930,000	~~	(Rice 1989b)
	Eastern tropical Pacific	~~	~~	26,053	13,797-38,309	(Whitehead 2003a)
	Costa Rica	~~	~~	1,360	832-2,248*	(Gerrodette and Palacios 1996)
	Central America north of Costa Rica	~~	~~	333	125-890*	(Gerrodette and Palacios 1996)
	Eastern temperate North Pacific	~~	~~	26,300	0-68,054*	(Barlow and Taylor 2005)
	~~	~~	~~	32,100	9,450-54,750*	(Barlow and Taylor 2005)
	NMFS-CA/OR/WA stock	~~	~~	2,833	CV=0.25*	(Carretta et al. 2008)
	NMFS-HI stock	~~	~~	7,082	2,918-11,246*	(Carretta et al. 2008)
Southern Hemisphere	Basinwide	547,600	~~	299,400	~~	(Gosho et al. 1984; IWC 1988; Perry et al. 1999)
	South of 60S	~~	~~	14,000	8,786-19,214*	(Butterworth et al. 1995) as

	South of 30S	~~	~~	128,000	17,613-238,387*	cited in (Perry et al. 1999) (Butterworth et al. 1995) as cited in (Perry et al. 1999)

***Note: Confidence Intervals (C.I.) not provided by the authors were calculated from Coefficients of Variation (C.V.) where available, using the computation from Gotelli and Ellison (2004).**

4.4.6.8 *North Atlantic*

190,000 sperm whales were estimated to have been in the entire North Atlantic, but CPUE data from which this estimate is derived are unreliable according to the IWC (Perry et al. 1999). The total number of sperm whales in the western North Atlantic is unknown (Waring et al. 2008). The best available current abundance estimate for western North Atlantic sperm whales is 4,804 based on 2004 data. The best available estimate for Northern Gulf of Mexico sperm whales is 1,665, based on 2003-2004 data, which are insufficient data to determine population trends (Waring et al. 2008). Sperm whale were widely harvested from the northeastern Caribbean (Romero et al. 2001) and the Gulf of Mexico where sperm whale fisheries operated during the late 1700s to the early 1900s (NMFS 2006d; Townsend 1935).

Natural threats. Sperm whales are known to be occasionally predated upon by killer whales (Jefferson and Baird 1991; Pitman et al. 2001) and large sharks (Best et al. 1984) and harassed by pilot whales (Arnbom et al. 1987; Palacios and Mate 1996; Rice 1989c; Weller et al. 1996; Whitehead 1995). Strandings are also relatively common events, with one to dozens of individuals generally beaching themselves and dying during any single event. Although several hypotheses, such as navigation errors, illness, and anthropogenic stressors, have been proposed (Goold et al. 2002; Wright 2005), direct widespread causes of strandings remain unclear. Calcivirus and papillomavirus are known pathogens of this species (Lambertsen et al. 1987; Smith and Latham 1978).

4.4.6.9 *Anthropogenic Threats*

Sperm whales historically faced severe depletion from commercial whaling operations. From 1800 to 1900, the IWC estimated that nearly 250,000 sperm whales were killed by whalers, with another 700,000 from 1910 to 1982 (IWC Statistics 1959-1983). However, other estimates have included 436,000 individuals killed between 1800-1987 (Carretta et al. 2005). However, all of these estimates are likely underestimates due to illegal and inaccurate killings by Soviet whaling fleets between 1947-1973. In the Southern Hemisphere, these whalers killed an estimated 100,000 whales that they did not report to the IWC (Yablokov et al. 1998), with smaller harvests in the Northern Hemisphere, primarily the North Pacific, that extirpated sperm whales from large areas (Yablokov and Zemsky 2000). Additionally, Soviet whalers disproportionately killed adult females in any reproductive condition (pregnant or lactating) as well as immature sperm whales of either gender.

Following a moratorium on whaling by the IWC, significant whaling pressures on sperm whales were eliminated. However, sperm whales are known to have become entangled in commercial fishing gear and 17 individuals are known to have been struck by vessels (Jensen and Silber 2004b). Japan maintains an active whaling fleet, killing up to 10 sperm whales annually (IWC 2008). In 2009, one sperm whale was killed during western North Pacific surveys (Bando et al. 2010).

In U.S. waters in the Pacific Ocean, sperm whales are known to have been incidentally captured only in drift gillnet operations, which killed or seriously injured an average of 9 sperm whales per year from 1991 - 1995 (Barlow et al. 1997). Interactions between longline fisheries and sperm whales in the Gulf of Alaska have been reported over the past decade (Hill and Demaster 1998; Rice 1989a). Observers aboard Alaskan sablefish and halibut longline vessels have documented sperm whales feeding on fish caught in longline gear in the Gulf of Alaska. During 1997, the first entanglement of a sperm whale in Alaska's longline fishery was recorded, although the animal was not seriously injured (Hill and Demaster 1998). The available evidence does not indicate sperm whales are being killed or seriously injured as a result of these interactions, although the nature and extent of interactions between sperm whales and long-line gear is not yet clear.

Contaminants have been identified in sperm whales, but vary widely in concentration based upon life history and geographic location, with northern hemisphere individuals generally carrying higher burdens (Evans et al. 2004). Contaminants include dieldrin, chlordane, DDT, DDE, PCBs, HCB and HCHs in a variety of body tissues (Aguilar 1983; Evans et al. 2004), as well as several heavy metals (Law et al. 1996). However, unlike other marine mammals, females appear to bioaccumulate toxins at greater levels than males, which may be related to possible dietary differences between females who remain at relatively low latitudes compared to more migratory males (Aguilar 1983; Wise et al. 2009). Chromium levels from sperm whales skin samples worldwide have varied from undetectable to 122.6 μg Cr/g tissue, with the mean (8.8 μg Cr/g tissue) resembling levels found in human lung tissue with chromium-induced cancer (Wise et al. 2009). Older or larger individuals do not appear to accumulate chromium at higher levels.

4.4.7 **Ringed Seal-Arctic DPS**

4.4.7.1 ***Description of the Species***

Ringed seals may consist of up to ten subspecies based upon skull morphology, coat coloration, behavior, and genetics, but the NMFS currently recognizes five (Arctic, Baltic, Ladoga, Okhotsk, and Saimaa) with the understanding that additional information which is currently lacking may find additional classifications within the Arctic subspecies (Allen 1880; Amano et al. 2002; Ameghino 1899; Anderson 1934; Chapskii 1955; Davis et al. 2008; Fedoseev 1984; Hyvärinen and Nieminen 1990; Kelly et al. 2009; King 1983; Ognev 1935; Palo 2003; Rice 1998c; Scheffer 1958; Sell 2008). This consultation deals only with the Arctic subspecies (DPS).

4.4.7.2 ***Distribution***

Arctic ringed seals do not come ashore, but rely entirely upon ice as a substrate for nursing, resting, and cover (Kelly 1988; Kelly et al. 2010a). In areas where ice disappears entirely (all other subspecies), land is used for some of these functions (Härkönen et al. 1998; Kunnasranta 2001; Lukin et al. 2006; Ognev 1935; Trukhin 2000)

4.4.7.3 *Growth and Reproduction*

Parturition occurs in late-winter to early-spring (February-April) in subnivean lairs during maximal snow depth; Sea of Okhotsk pups are born in moving pack ice either in lairs. Nursing continues for an average of 39 days postpartum, but can vary from 3-9 weeks (Fedoseev 1975; Hammill et al. 1991; Käkelä and Hyvärinen 1993; Lydersen and Hammill 1993b). Pups spend about half of their time in water during the nursing period, diving up to 89 m deep and for as long as 12 minutes (Lydersen and Hammill 1993b). Just after weaning, pups shed their fetal coat for an adult-type coat (Kelly 1988; Lydersen and Hammill 1993b). For all individuals, molting occurs from mid-May to mid-July with some regional variation in timing; individuals spend long periods out of the water and metabolism decreases by nearly 20% (Ashwell-Erickson et al. 1986; Kelly et al. 2010a; Kelly and Quakenbush 1990; Kunnasranta et al. 2002; McLaren 1958; Smith 1973; Smith and Hammill. 1981). However, molting can be differed until August if suitable ice is not available (Bychkov 1965; McLaren 1958). Sexual maturity occurs at 4-8 years of age for females and 5-7 years for males, although individual body condition and population structure can influence the timing (Burns and Fay 1970; Frost and Lowry 1981; Holst et al. 1999; Kelly 1988; Kovacs 2007; Lydersen and Gjertz 1987; Mansfield 1967; McLaren 1958; Reeves 1998; Sipilä 2003; Sipilä and Hyvärinen 1998; Sipila et al. 1999; Smith 1973; Smith and Stirling 1975; Tikhomirov 1968). Pregnancy or ovulation rates in the Arctic have been found to vary between 0.45 and 0.86, although later revisions eliminating young individuals reduced much of the variability, with averages between 0.63 and 0.81 in various locations (Hammill 1987; Johnson et al. 1966; Nazarenko 1965; Reeves 1998; Smith 1987; Smith et al. 1979). Ringed seals live to between 15 and 28 years of age on average, with maximum lifespan measured at 48 years (Frost and Lowry 1981; Helle 1980; Holst et al. 1999; Lydersen and Gjertz 1987; McLaren 1958; Sipilä and Hyvärinen 1998; Sipila et al. 1999; Smith 1973). Mortality rates derived from harvest data suggest a mortality rate of 30-41% for pups, dropping to 10% annually by sexual maturity and slowly increasing after age 15 (Kelly 1988). Body condition changes drastically with season, with extensive blubber loss during spring and early summer due to reduced foraging, molting, and increased involvement with breeding and/or rearing of young (Ameghino 1899; Fedoseev 1965; Hammill et al. 1991; Johnson et al. 1966; Lowry et al. 1980; Lydersen 1995; Lydersen and Hammill 1993a; Lydersen and Kovacs 1999; McLaren 1958; Pikharev 1946; Ryg et al. 1990; Ryg and Øritsland 1991; Smith 1987). Females have been found to lose 19% of their body weight between March and June while males lost 12% (Ryg et al. 1990). These body reserves are replaced during the rest of the year (Ameghino 1899).

The ringed seal mating system is believed to polygamous, with males defending territories they mark with a strong scent (particularly around breathing holes and adjacent snow)(Ameghino 1899; Chapskii 1940; Hardy et al. 1991; Kelly et al. 2010a; Ognev 1935; Ryg et al. 1992; Smith 1981; Smith 1987; Stirling 1977). Males in the Arctic rut from late-March to mid-May, with regional peaks in activity (Bakulina 1989; McLaren 1958). Adult and subadult males appear to have bite marks and engage in aggressive behavior during the breeding season, a time when underwater vocalizations are documented to increase (Rautio et al. 2009; Smith 1987; Smith and Hammill. 1981; Stirling et al. 1983). Males may guard territories or mates underneath the sea ice, based upon interpretations of shallow dive depths and restricted movements of males versus females during the breeding season (Ameghino 1899; Kelly et al. 2010a; Kelly and Wartzok 1996; Rautio et al. 2009; Stirling 1973; Stirling et al. 1983). Although size does not appear to correlate to the number of female neighbors, male age does and may influence reproductive success for individual males (Krafft et al. 2007). Mating has not been observed to date, but is thought to occur underwater near the females' lair (Ameghino 1899; Kelly 1988). Arctic females ovulate in May and early-June shortly after parturition, although ovulation can be suppressed if body condition is insufficient (Ameghino 1899; Harwood et al. 2000; Johnson et al. 1966; Smith 1973; Smith 1987). Implantation is delayed by 3-3.5 months, followed by an approximate eight-month gestation for a single pup or, rarely, twins (Fedoseev 1975; McLaren 1958; Smith 1987). Births occur at a 1:1 sex ratio (Fedoseev 1975; Frost and Lowry 1981; Helle 1980; Lydersen and Gjertz 1987; McLaren 1958; Sipilä et al. 1990; Sipila et al. 1999; Smith 1973).

4.4.7.4 *Behavior*

Arctic ringed seals are strongly driven by ice cover, with a typical year broken-up into three "ecological seasons": August to October as an open water or feeding period when intensive feeding occurs, an early-winter to March or May period when seals are resting in subsurface caves, and a breeding/molting period once ice begins to melt and break-up (Ameghino 1899; Born et al. 2004; Kelly et al. 2010a).

Arctic ringed seals in the Beaufort and Chukchi Seas spend most of their time either in water or in snowy lairs (90% August-November, 20% December-March), except during the spring molt (May-June) when they spend an average of 55% of their time basking on ice (Kelly et al. 2010a; Smith and Stirling 1975). Arctic ringed seals rest in their lairs from April to mid-May (mostly at night)(Kelly et al. 2010a). Ringed seals spend more time on ice once spring temperatures warm and lairs start becoming exposed (March to early June in the Bering and Chukchi Seas)(Heptner et al. 1976; Kelly and Quakenbush 1990; Kunnasranta et al. 2002; Lowry et al. 1980; Tikhomirov 1961). Basking while molting reaches a peak in the Arctic during June (Born et al. 2002; Carlens et al. 2006; Harwood et al. 2007; Kelly et al. 2010a; Moulton et al. 2002; Smith 1987; Smith and Hammill. 1981). Individuals frequently return to the water, with pups entering and exiting more frequently than adults (Carlens et al. 2006). However, time out of water increases in June (Kelly et al. 2010a). When hauled out, individuals are vigilant and oriented for quick reentry into the breathing hole and/or facing downwind (Finley 1979; Kingsley and Stirling 1991). As sea ice breaks up, individuals spend more time in water (Ameghino 1899).

Ringed seals are able to dive to depths in excess of 500 m for 39 minutes or more, although most dives are less than 10 minutes in duration and extend to whatever depth the ocean bottom is (Born et al. 2004; Gjertz et al. 2000; Harkonen et al. 2008; Kelly and Wartzok 1996; Kunnasranta et al. 2002; Lydersen 1991; Teilmann et al. 1999). Diving ability improves with body size (Kelly 1997; Kelly and Wartzok 1996; Teilmann et al. 1999). Diving and resting patterns appear to be seasonally influenced, with more time spent out of water during the day and diving at night from spring to early-summer (breeding and molting) and the opposite true at all other times (Carlens et al. 2006; Kelly et al. 2010a; Kelly and Quakenbush 1990; Kunnasranta et al. 2002; Lydersen 1991; Teilmann et al. 1999).

4.4.7.5 ***Migration and Movements***

Movements can be most wide-ranging during the "open water" period from summer to fall, with individuals potentially ranging several hundred kilometers; some individuals may undergo much more limited movement (Bailey and Hendee 1926; Gjertz et al. 2000; Harkonen et al. 2008; Harwood and Smith 2003; Heide-Jørgensen et al. 1992; Kapel et al. 1998; Kelly and Wartzok 1996; Smith 1976; Smith et al. 1973; Smith and Stirling 1978; Teilmann et al. 1999). Following the period of open water foraging, adults return to the same areas they came from the previous winter (Kelly et al. 2010a; Koskela et al. 2002; Krafft et al. 2007; Kunnasranta et al. 2001; Sipilä et al. 1996; Smith and Hammill. 1981). Movements are more limited in late-fall and winter, ranging over just a few square kilometers unless they have access to leads in ice, in which case individuals can range over thousands of square kilometers (Born et al. 2004; Harwood et al. 2007; Kelly et al. 2010a; Kelly and Quakenbush 1990). As temperatures warm and snow melts in late-spring and early-summer, ice remains largely intact but seals spend extensive time basking in the sun during the molt (Finley 1979; Kelly et al. 2010a; Smith 1973). As Arctic individuals complete molting, they spend more and more time in the water (Kelly et al. 2010a).

4.4.7.6 ***Habitat***

Ringed seals haul out on ice year-round to rest, although they may also use rocky reefs, islands, shorelines, and sand bars when ice is unavailable (Harkonen et al. 2008; Hyvärinen et al. 1995; Krylov et al. 1964; Lukin et al. 2006; Sipilä et al. 1996). Ringed seals are particularly adept at scrapping and clawing breathing holes (even in heavy winter ice up to two meters thick) as well as sublivean (within snow pack) lairs over these holes (Ameghino 1899; Bailey and Hendee 1926; Hammill and Smith 1989; Kelly 1996; Lukin and Potelov 1978; Ognev 1935; Smith and Stirling 1975). As snow accumulates above holes, ringed seals excavate lairs for resting, nursing, thermoregulation, predator avoidance, and parturition (Ameghino 1899; Bengtson et al. 2005; Burns 1970; Finley and Evans 1983; Hammill and Smith 1991; McLaren 1958; Smith et al. 1991; Wiig et al. 1999). Models of thermoregulation suggest that pups could not thermoregulate effectively in some areas without the thermal refuge that lairs provide (Kelly 1988; Smith et al. 1991; Taugbøl 1982).

4.4.7.7 ***Status and Trends***

Arctic DPS ringed seals were proposed for listing as threatened on December 10, 2010 (75 FR 77476). As with other ice seals, data for estimating abundance and trends is extremely difficult to obtain and no comprehensive studies exist. Worldwide estimates have been suggested at several million individuals (Reeves 1998; Stirling and Calvert 1979).

The Arctic subspecies, due to its wide distribution, is believed to be the most abundant subspecies of ringed seal. Estimates at various Greenland and Baffin Bay locations include: 200,000 near Svalbard (Jødestøl and Ugland 1994), 7,585 near Spitsbergen (Carlens et al. 2006), more than 28,000 in Kong Oscars Fjord, Scoresby Sund (Born et al. 1998) , 67,000 in northeastern along the shore of Baffin Bay and 417,000 within the pack ice (Finley and Evans 1983) , 97,800 for eastern Baffin Bay (Miller et al. 1982) , and 787,000 on pack ice of Canada and Greenland (Finley and Evans 1983). This last estimate is the only comprehensive estimate for the region and abundance has been suggested to be stable (Ameghino 1899). Hudson Bay has also been surveyed frequently, with estimates including 455,000 in western Hudson Bay

(Smith 1975), 280,000 for the same region a quarter century later (Lunn et al. 1997), 73,170 in 2007 and 33,701 in 2008 (Ferguson and Secretariat 2009). The BRT concluded that a mean between these two last estimates (53,436) was most reasonable; no estimate of trend is available (Ameghino 1899). Early estimates of ringed seals in the Alaskan Beaufort Sea estimated 40,000 seals during the winter months (Burns and Harbo 1972). Bengtson et al. (2005) estimated 252,488 individuals in 1999 and 208,857 in 2000 for the Alaskan Chukchi Sea. Estimates of 250,000 individuals in the shorefast ice and 1-1.5 million individuals in the pack ice for the combined Beaufort and Chukchi Seas have been made (Frost 1985). An estimated 30,900 individuals occurred in the Amundsen Gulf in 1981 and 70,500 in 1982 (Kingsley and Lunn 1983). The BRT estimated that at least one million individuals inhabit the Beaufort and Chukchi Seas (Ameghino 1899). Estimates from the White, Barents, Kara, and East Siberian Seas are generally lacking, although these areas encompass half of the Arctic subspecies' habitat, but some estimates have been put forth, the largest being 2-2.5 million for the eastern Barents Sea to the Bering Sea (Heptner et al. 1976). Estimates for the Barents Sea include 35,000-50,000 individuals from 1988-1994 as well as 24,000-30,000 individuals in the White Sea from the 1970s-1980s (Ognetov 2002). The Kara Sea has been estimated to support 90,000-150,000 individuals (Ognetov 2002).

4.4.7.8 *Natural Threats*

Predators are the main natural threat of ringed seals and include polar and brown bears, Arctic and red foxes, gray wolves, lynx, European mink, walruses, killer whales, Greenland sharks, common ravens, and glaucous gulls (Burns and Eley 1976; Fay et al. 1990; Heptner et al. 1976; Melnikov and Zagrebin 2005; Sipilä 2003). Ringed seals are one of the primary prey species for polar bears, with ringed seals composing 80-98% of polar bear diet in the Beaufort Sea and Hudson Bay region during some periods (Derocher et al. 2004; Heptner et al. 1976; Stirling and Parkinson. 2006). From 8-44% of pup production may be removed by polar bear predation (Hammill and Smith 1991). Ringed seals are particularly vulnerable to predation from polar bears as they spend more time on ice molting as well as when lairs disintegrate earlier than expected, such as from rainfall or low snowfall (Hammill and Smith 1991; Messier et al. 1992; Stirling 1974). Early lair exposure can also expose pups to avian predation (Gjertz and Lydersen 1983; Kumlien 1879; Lydersen 1998; Lydersen and Gjertz 1987; Lydersen et al. 1987; Lydersen and Ryg 1990; Lydersen and Smith 1989). Along with polar bears, Arctic foxes can exert regionally high levels of predation on newborn pups from the Arctic ringed seal subspecies (Kelly and Quakenbush 1990; Kelly et al. 1986; Lydersen and Gjertz 1984; Smith 1976).

4.4.7.9 *Anthropogenic Threats*

The Arctic DPS was proposed due to the potential impact that a warming climate may have on the biology of the species, specifically the availability of ice and prey abundance and distribution, as well as possible impacts of ocean acidification on the marine food chain (Ameghino 1899). As ringed seals rely upon lairs for resting, nursing, thermoregulation, predator avoidance, and parturition, early spring break-ups can adversely impact growth, condition, and survival of pups (Harwood et al. 2000; Lukin et al. 2006; Stirling and Smith 2004). The ringed seal BRT expects early breakups to occur more frequently as a result of warming temperatures and adversely impact ringed seal productivity and abundance via pup survival (Ameghino 1899; Ferguson et al. 2005; Kelly 2001; Smith and Hammill 1980; Stirling and Smith 2004). Prey distribution, particularly of Arctic cod, may also shift as a result of temperature changes (Ameghino 1899).

Ringed seals have been hunted for subsistence for 1000s of years, a practice which continues presently (ACIA 2005; Hovelsrud et al. 2008; Kovacs 2007; Krupnik 1988). Alaskan harvests killed 7,000-15,000 individuals annually from 1962-1972, but declined to 3,000-6,000 during 1973-1977 and 2,000-3,000 by 1979 (Frost 1985). Currently, 9,500 individuals are estimated to be harvested annually in Alaska (Allen and Angliss 2010). A few thousand individuals were also harvested in the Russian Bering Sea between 1961 and 1969, which likely continued through 1990 (Fedoseev 2000). By far the largest Russian harvests of ringed seals occurred in the Russian Bering and Chukchi Seas by subsistence hunters. Native harvests are estimated at 25,000 in the late 1930s, 23,500 by the 1940s, and 15,500 by the late 1950s (Heptner et al. 1976). Harvests along the Bering Sea were 30,000-35,000 after World War II, but decreased to 10,000-12,000 annually (Popov 1982). Fedoseev (1984) estimated the combined harvest along the Bering, Chukchi, and East Siberian Seas was 40,000 individuals between 1940 and 1954. However, shore-based harvests have been restricted to 2,000-3,000 individuals since 1970 (Popov 1982). Harvests reportedly numbered 991-3,607 individuals along the Bering and Chukchi Seas between 1979 and 1983 (Mineev 1981; Mineev 1984). The decline in harvests was likely due to native peoples shifting to a modern lifestyle (Fedoseev 1984).

A variety of contaminants have been identified in ringed seals, some to the point of causing sterility. Organic contaminants have also been identified in ringed seals, including DDT, DDE, and PCBs (Addison et al. 2005; Addison and Smith 1974; Bang et al. 2001; Helle et al. 1983; Helle et al. 1976a; Helle et al. 1976b; Helle and Stenman 1984; Kostamo et al. 2000; Kucklick et al. 2002; Nakata et al. 1998; Nyman et al. 2002; Riget et al. 2006; Sipilä and Hyvärinen 1998). Perflourinated compounds have also been identified in ringed seals, with little understanding of their significance (Bossi et al. 2005; Butt et al. 2007; Kannan et al. 2002; Kannan et al. 2001; Martin et al. 2004; Quakenbush and Citta. 2008).

Heavy metals, including mercury, cadmium, lead, selenium, arsenic, zinc, chromium and nickel have been found to accumulate in ringed seal liver and kidney (Atwell et al. 1998; Gaden et al. 2009; Helle 1981; Hyvärinen et al. 1998; Koeman et al. 1975; Quakenbush and Sheffield 2007; Riget et al. 2005; Smith and Armstrong 1978; Sonne et al. 2009; Wagemann 1985; Wagemann 1989; Wagemann et al. 1996). Mercury and selenium accumulate with age (Dietz et al. 1998; Helle 1981; Hyvärinen et al. 1998; Medvedev et al. 1997; Riget et al. 2005; Smith and Armstrong 1978). Cadmium peaked at 5-10 years of age and declined thereafter (Dietz et al. 1998). Mercury has been found to be higher in Baltic females than males (Helle 1981). Nickel might play a role in stillborn pup mortality (Hyvärinen and Sipilä 1984).

4.4.8 **Green Sea Turtle**

4.4.8.1 ***Distribution***

Green sea turtles have a circumglobal distribution, occurring throughout tropical, subtropical waters, and, to a lesser extent, temperate waters.

4.4.8.2 *Population designation*

Populations are distinguished generally by ocean basin and more specifically by nesting location (Table 36).

Based upon genetic differences, two or three distinct regional clades may exist in the Pacific: western Pacific and South Pacific islands, eastern Pacific, and central Pacific, including the rookery at French Frigate Shoals, Hawaii (Dutton and Balazs In review; Dutton et al. 1996). In the eastern Pacific, green sea turtles forage from San Diego Bay, California to Mejillones, Chile. Individuals along the southern foraging area originate from Galapagos Islands nesting beaches, while those in the Gulf of California originate primarily from Michoacán. Green turtles foraging in San Diego Bay and along the Pacific coast of Baja California originate primarily from rookeries of the Islas Revillagigedos (Dutton 2003).

Table 36. Locations and most recent abundance estimates of threatened green sea turtles as annual nesting females (AF), annual nests (AN), annual egg production (EP), and annual egg harvest (EH).

Location	Most recent abundance	Reference
Western Atlantic Ocean		
Tortuguero, Costa Rica	17,402-37,290 AF	(Troëng and Rankin 2005)
Aves Island, Venezuela	335-443 AF	(Vera 2007)
Galibi Reserve, Suriname	1,803 AF	(Weijerman et al. 1998)
Isla Trindade, Brazil	1,500-2,000 AF	(Moreira and Bjorndal 2006)
Central Atlantic Ocean		
Ascension Island, UK	3,500 AF	(Broderick et al. 2006)
Eastern Atlantic Ocean		
Poilao Island, Guinea-Bissau	7,000-29,000 AN	(Catry et al. 2009)
Bioko Island, Equatorial Guinea	1,255-1,681 AN	(Tomas et al. 1999)
Mediterranean Sea		
Turkey	214-231 AF	(Broderick et al. 2002)
Cyprus	121-127 AF	(Broderick et al. 2002)
Israel / Palestine	1-3 AF	(Kuller 1999)
Syria	100 AN	(Rees et al. 2005)
Western Indian Ocean		
Eparces Islands	2,000-11,000 AF	(Le Gall et al. 1986)
Comoros Islands	5,000 AF	S. Ahamada, pers. comm. 2001
Seychelles Islands	3,535-4,755 AF	J. Mortimer, pers. comm. 2002
Kenya	200-300 AF	(Okemwa and Wamukota 2006)
Northern Indian Ocean		
Ras al Hadd, Oman	44,000 AN	S. Al-Saady, pers. comm. 2007
Sharma, Yemen	15 AF	(Saad 1999)
Karan Island, Saudi Arabia	408-559 AF	(Pilcher 2000)
Jana and Juraid Islands, Saudi Arabia	643 AN	(Pilcher 2000)
Hawkes Bay and Sandspit, Pakistan	600 AN	(Asrar 1999)
Gujarat, India	461 AN	(Sunderraj et al. 2006)
Sri Lanka	184 AF	(Kapurisinghe 2006)
Eastern Indian Ocean		
Thamihla Kyun, Myanmar	<250,000 EH	(Thorbjarnarson et al. 2000)
Pangumbahan, Indonesia	400,000 EH	(Schulz 1987)
Suka Made, Indonesia	395 AN	C. Limpus, pers. comm. 2002
Western Australia	3,000-30,000 AN	R. Prince, pers. comm. 2001
Southeast Asia		
Gulf of Thailand	250 AN	Charuchinda pers. comm. 2001

Vietnam	239 AF	(Hamann et al. 2006a)
Berau Islands, Indonesia	4,000-5,000 AF	(Schulz 1984)
Turtle Islands, Philippines	1.4 million EP	(Cruz 2002)
Sabah Turtle Islands, Malaysia	8,000 AN	(Chan 2006)
Sipadan, Malaysia	800 AN	(Chan 2006)
Sarawak, Malaysia	2,000 AN	(Liew 2002)
Enu Island (Aru Islands)	540 AF	Dethmers, in preparation
Terengganu, Malaysia	2,200 AN	(Chan 2006)
Western Pacific Ocean		
Heron Island and southern Great Barrier Reef areas, Australia	5,000-10,000 AF	(Maison et al. 2010)
Raine Island and northern Great Barrier Reef areas, Australia	10,000-25,000 AF	(Limpus et al. 2003) (Maison et al. 2010)
Coringa-Herald National Nature Reserve, Australia	1,445 AF	(Maison et al. 2010)
Guam	45 AF	(Cummings 2002)
Phoenix Islands, Kiribati	100-300 AF	(Maison et al. 2010)
Ogasawara Islands, Japan	500 AF	(Chaloupka et al. 2007)
Micronesia	500-1,000 AF	(Maison et al. 2010)
Marshall Islands	100-500 AF	(Maison et al. 2010)
New Caledonia	1,000-2,000 AF	(Maison et al. 2010)
Central and Eastern Pacific Ocean		
French Frigate Shoals, Hawaii	400 AF	(Balazs and Chaloupka 2006)
Michoacán, Mexico	1,395 AF	C. Delgado, pers. comm. 2006
Central American Coast	184-344 AN	(López and Arauz 2003)
Galapagos Islands, Ecuador	1,650 AF	(Zárate et al. 2006)

4.4.8.3 *Growth and Reproduction*

Most green sea turtles exhibit particularly slow growth rates, which have been attributed to their largely plant-eating diet (Bjorndal 1982). Growth rates of juveniles vary substantially among populations, ranging from <1 cm/year (Green 1993) to >5 cm/year (McDonald Dutton and Dutton 1998), likely due to differences in diet quality, duration of foraging season (Chaloupka et al. 2004), and density of turtles in foraging areas (Balazs and Chaloupka 2004; Bjorndal et al. 2000a; Seminoff et al. 2002b). If individuals do not feed sufficiently, growth is stunted and apparently does not compensate even when greater-than-needed resources are available (Roark et al. 2009). In general, there is a tendency for green sea turtles to exhibit monotonic growth (declining growth rate with size) in the Atlantic and non-monotonic growth (growth spurt in mid-size classes) in the Pacific, although this is not always the case (Balazs and Chaloupka 2004; Chaloupka and Musick 1997; Seminoff et al. 2002b). It is estimated that green sea turtles reach a maximum size just under 100 cm in carapace length (Tanaka 2009). A female-bias has been identified from studies of green sea turtles (Wibbels 2003).

Consistent with slow growth, age-to-maturity for green sea turtles appears to be the longest of any sea turtle species and ranges from ~20-40 years or more (Balazs 1982; Chaloupka et al. 2004; Chaloupka and Musick 1997; Frazer and Ehrhart 1985b; Hirth 1997; Limpus and Chaloupka 1997; Seminoff et al. 2002b; Zug et al. 2002; Zug and Glor 1998). Estimates of reproductive longevity range from 17 to 23 years (Carr et al. 1978; Chaloupka et al. 2004; Fitzsimmons et al. 1995). Considering that mean duration between females returning to nest ranges from 2 to 5 years (Hirth 1997), these reproductive longevity estimates suggest that a female may nest 3 to 11 seasons over the course of her life. Each female deposits 1-7 clutches (usually 2-3) during the breeding season at 12-14 day intervals. Mean clutch size is highly variable among populations, but averages 110-115 eggs/nest. Females usually have 2-4 or more years between breeding seasons, whereas males may mate every year (Balazs 1983). Based on reasonable means of three nests per season and 100 eggs per nest (Hirth 1997), a female may deposit 9 to 33 clutches, or about 900 to 3,300 eggs, during her lifetime. Nesting sites appear to be related to beaches with relatively high exposure to wind or wind-generated waves (Santana Garcon et al. 2010).

Once hatched, sea turtles emerge and orient towards a light source, such as light shining off the ocean. They enter the sea in a "frenzy" of swimming activity, which decreases rapidly in the first few hours and gradually over the first several weeks (Ischer et al. 2009; Okuyama et al. 2009). Factors in the ocean environment have a major influence on reproduction (Chaloupka 2001; Limpus and Nicholls 1988; Solow et al. 2002). It is also apparent that during years of heavy nesting activity, density dependent factors (beach crowding and digging up of eggs by nesting females) may impact hatchling production (Tiwari et al. 2005; Tiwari et al. 2006). Precipitation, proximity to the high tide line, and nest depth can also significantly affect nesting success (Cheng et al. 2009). Precipitation can also be significant in sex determination, with greater nest moisture resulting in a higher proportion of males (Leblanc and Wibbels 2009). Green sea turtles often return to the same foraging areas following nesting migrations (Broderick et al. 2006; Godley et al. 2002). Once there, they move within specific areas, or home ranges, where they routinely visit specific localities to forage and rest (Godley et al. 2003; Makowski et al. 2006; Seminoff and Jones 2006; Seminoff et al. 2002a; Taquet et al. 2006). It is also apparent that some green sea turtles remain in pelagic habitats for extended periods, perhaps never recruiting to coastal foraging sites (Pelletier et al. 2003).

In general, survivorship tends to be lower for juveniles and subadults than for adults. Adult survivorship has been calculated to range from 0.82-0.97 versus 0.58-0.89 for juveniles (Chaloupka and Limpus 2005; Seminoff et al. 2003; Troëng and Chaloupka 2007), with lower values coinciding with areas of human impact on green sea turtles and their habitats (Bjorndal et al. 2003; Campbell and Lagueux 2005).

4.4.8.4 ***Migration and Movement***

Green sea turtles are highly mobile and undertake complex movements through geographically disparate habitats during their lifetimes (Musick and Limpus 1997b; Plotkin 2003). The periodic migration between nesting sites and foraging areas by adults is a prominent feature of their life history. After departing as hatchlings and residing in a variety of marine habitats for 40 or more years (Limpus and Chaloupka 1997), green sea turtles make their way back to the same beach from which they hatched (Carr et al. 1978; Meylan et al. 1990). At approximately 20-25 cm carapace length, juveniles leave pelagic habitats and enter benthic foraging areas (Bjorndal 1997). Green sea turtles spend the majority of their lives in coastal foraging grounds. These areas include both open coastline and protected bays and lagoons. While in these areas, green sea turtles rely on marine algae and seagrass as their primary dietary constituents, although some populations also forage heavily on invertebrates. There is some evidence that individuals move from shallow seagrass beds during the day to deeper areas at night (Hazel 2009). However, avoidance of areas of greater than 10 m when moderate depths of 5-10 m with sea grass beds has been found, with speed and displacement from capture locations being similar at night as during the daytime (Senko et al. 2010a).

4.4.8.5 ***Habitat***

Green turtles appear to prefer waters that usually remain around 20º C in the coldest month, but may occur considerably north of these regions during warm-water events, such as El Niño. As ocean temperatures increase in the spring, green sea turtles migrate from southeastern U.S. waters to Long Island Sound, Peconic Bay, and possibly Nantucket Sound, where an abundance of algae and eelgrass occurs in estuaries here (Lazell 1980; Morreale and Standora 1998). Stinson (1984) found green turtles to appear most frequently in U.S. coastal waters with temperatures exceeding 18º C. Further, green sea turtles seem to occur preferentially in drift lines or surface current convergences, probably because of the prevalence of cover and higher prey densities that associate with flotsam. For example, in the western Atlantic Ocean, drift lines commonly containing floating *Sargassum* spp. are capable of providing juveniles with shelter (NMFS and USFWS 1998a). Along Florida's Atlantic coast, juvenile green turtles occur in high wave-energy, nearshore reef environments less than 2 m deep that support an abundance of macroalgae (Holloway-Adkins 2006). During winter, the highest green sea turtle concentration is just north of Cape Canaveral. Juvenile green turtles are the second-most abundant sea turtle species in North Carolina summer developmental habitats, occurring year-round within continental shelf waters, while adults are restricted to more southern latitudes (Epperly et al. 1995b). Green sea turtles are likely most abundant in nearshore northeastern waters in September (Berry et al. 2000). Most green sea turtle sightings north of Florida are of juveniles and occur during late spring to early fall (Burke et al. 1992; Epperly et al. 1995a; Lazell 1980). Underwater resting sites include coral recesses, the underside of ledges, and sand bottom areas that are relatively free of strong currents and disturbance. Available information indicates that green turtle resting areas are near feeding areas (Bjorndal and Bolten 2000). Strong site fidelity appears to be a characteristic of juveniles green sea turtles along the Pacific Baja coast (Senko et al. 2010b).

Green sea turtles in the Gulf of Mexico tend to remain along the coast (lagoons, channels, inlets, and bays), with nesting primarily occurring in Florida and Mexico and infrequent nesting in all other areas (Landry and Costa 1999; Meylan et al. 1995a; NMFS and USFWS 1991; USAF 1996). Juveniles use the estuarine and nearshore waters of central Florida throughout the year, including (Renaud et al. 1995). Foraging areas seem to be based upon seagrass and macroalgae abundance, such as in the Laguna Madre of Texas. However, green sea turtles may also occur in offshore regions, particularly during migration and development.

4.4.8.6 ***Vocalization and Hearing***

Sea turtles are low-frequency hearing specialists, typically hearing frequencies from 30 to 2,000 Hz, with a range of maximum sensitivity between 100 and 800 Hz (Bartol et al. 1999b; Lenhardt 2002; Lenhardt 1994; Moein Bartol and Ketten 2006; Ridgway et al. 1969). Hearing below 80 Hz is less sensitive but still possible (Lenhardt 1994). Based upon auditory brainstem responses green sea turtles have been measured to hear in the 50-1600 Hz range (Dow et al. 2008), with greatest response at 300 Hz (Yudhana et al. 2010); a value verified by Moein Bartol and Ketten

(2006). Other studies have found greatest sensitivities are 200-400 Hz for the green turtle with a range of 100-500 Hz (Moein Bartol and Ketten 2006; Ridgway et al. 1969) and around 250 Hz or below for juveniles (Bartol et al. 1999b). However, Dow et al. (2008) found best sensitivity between 50 and 400 Hz.

These hearing sensitivities are similar to those reported for two terrestrial species: pond and wood turtles. Pond turtles respond best to sounds between 200 and 700 Hz, with slow declines below 100 Hz and rapid declines above 700 Hz, and almost no sensitivity above 3000 Hz (Wever and Vernon 1956). Wood turtles are sensitive up to about 500 Hz, followed by a rapid decline above 1000 Hz and almost no responses beyond 3000 or 4000 Hz (Patterson 1966).

4.4.8.7 ***Status and Trends***

Federal listing of the green sea turtle occurred on July 28, 1978, with all populations listed as threatened except for the Florida and Pacific coast of Mexico breeding populations, which are endangered (43 FR 32800). Consideration of the status of populations outside of the action area is important under the present analysis to determine the riskto the affected population(s) bears on the status of the species as a whole. The International Union for Conservation of Nature (IUCN) has classified the green turtle as "endangered."

No trend data are available for almost half of the important nesting sites, where numbers are based on recent trends and do not span a full green sea turtle generation, and impacts occurring over four decades ago that caused a change in juvenile recruitment rates may have yet to be manifested as a change in nesting abundance. The numbers also only reflect one segment of the population (nesting females), who are the only segment of the population for which reasonably good data are available and are cautiously used as one measure of the possible trend of populations.

Table 36 summarizes nesting abundance for 46 nesting sites worldwide. These include both large and small rookeries believed to be representative of the overall trends for their respective regions. Based on the mean annual reproductive effort, 108,761-150,521 females nest each year among the 46 sites. Overall, of the 26 sites for which data enable an assessment of current trends, 12 nesting populations are increasing, 10 are stable, and four are decreasing. Long-term continuous datasets of 20 years are available for 11 sites, all of which are either increasing or stable. Despite the apparent global increase in numbers, the positive overall trend should be viewed cautiously because trend data are available for just over half of all sites examined and very few data sets span a full green sea turtle generation (Seminoff 2004b).

Atlantic Ocean. Primary sites for green sea turtle nesting in the Atlantic/Caribbean include: (1) Yucatán Peninsula, Mexico; (2) Tortuguero, Costa Rica; (3) Aves Island, Venezuela; (4) Galibi Reserve, Suriname; (5) Isla Trindade, Brazil; (6) Ascension Island, United Kingdom; (7) Bioko Island, Equatorial Guinea; and (8) Bijagos Achipelago, Guinea-Bissau (NMFS and USFWS 2007a). Nesting at all of these sites was considered to be stable or increasing with the exception of Bioko Island and the Bijagos Archipelago where the lack of sufficient data precludes a meaningful trend assessment for either site (NMFS and USFWS 2007a). Seminoff (2004a) reviewed green sea turtle nesting data for eight sites in the western, eastern, and central Atlantic.

Seminoff (2004a) concluded that all sites in the central and western Atlantic showed increased nesting, with the exception of nesting at Aves Island, Venezuela, while both sites in the eastern Atlantic demonstrated decreased nesting. These sites are not inclusive of all green sea turtle nesting in the Atlantic. However, other sites are not believed to support nesting levels high enough that would change the overall status of the species in the Atlantic (NMFS and USFWS 2007a).

By far, the most important nesting concentration for green sea turtles in the western Atlantic is in Tortuguero, Costa Rica (NMFS and USFWS 2007a). Nesting in the area has increased considerably since the 1970s and nest count data from 1999-2003 suggest nesting by 17,402-37,290 females per year (NMFS and USFWS 2007a). The number of females nesting per year on beaches in the Yucatán, at Aves Island, Galibi Reserve, and Isla Trindade number in the hundreds to low thousands, depending on the site (NMFS and USFWS 2007a).

The vast majority of green sea turtle nesting within the southeastern U.S. occurs in Florida (Johnson and Ehrhart 1994; Meylan et al. 1995b). Green sea turtle nesting in Florida has been increasing since 1989 (Florida Fish and Wildlife Conservation Commission, Florida Marine Research Institute Index Nesting Beach Survey Database). Since establishment of index beaches in 1989, the pattern of green turtle nesting shows biennial peaks in abundance with a generally positive trend during the ten years of regular monitoring. This is perhaps due to increased protective legislation throughout the Caribbean (Meylan et al. 1995b). A total statewide average (all beaches, including index beaches) of 5,039 green turtle nests were laid annually in Florida between 2001 and 2006, with a low of 581 in 2001 and a high of 9,644 in 2005 (NMFS and USFWS 2007a). Data from index nesting beaches substantiate the dramatic increase in nesting. In 2007, there were 9,455 green turtle nests found just on index nesting beaches, the highest since index beach monitoring began in 1989. The number fell back to 6,385 in 2008, further dropping under 3,000 in 2009, but that consecutive drop was a temporary deviation from the normal biennial nesting cycle for green turtles, as 2010 saw an increase back to 8,426 nests on the index nesting beaches (FWC Index Nesting Beach Survey Database). Occasional nesting has been documented along the Gulf coast of Florida (Meylan et al. 1995b). More recently, green turtle nesting occurred on Bald Head Island, North Carolina; just east of the mouth of the Cape Fear River; on Onslow Island; and on Cape Hatteras National Seashore. In 2010, a total of 18 nests were found in North Carolina, 6 nests in South Carolina, and 6 nests in Georgia (nesting databases maintained on www.seaturtle.org). Increased nesting has also been observed along the Atlantic coast of Florida, on beaches where only loggerhead nesting was observed in the past (Pritchard 1997). Recent modeling by Chaloupka et al. (2008a) using data sets of 25 years or more has resulted in an estimate of the Florida nesting stock at the Archie Carr National Wildlife Refuge growing at an annual rate of 13.9%, and the Tortuguero, Costa Rica, population growing at 4.9%.

There are no reliable estimates of the number of immature green sea turtles that inhabit coastal areas of the southeastern U.S. However, information on incidental captures of immature green sea turtles at the St. Lucie Power Plant in St. Lucie County, Florida, shows that the annual number of immature green sea turtles captured by their offshore cooling water intake structures has increased significantly. Green sea turtle annual captures averaged 19 for 1977-1986, 178 for

1987-1996, and 262 for 1997-2001 (Florida Power and Light Company St. Lucie Plant 2002). More recent unpublished data shows 101 captures in 2007, 299 in 2008, 38 in 2009 (power output was cut—and cooling water intake concomitantly reduced—for part of that year) and 413 in 2010. Ehrhart et al. (2007) documented a significant increase in in-water abundance of green turtles in the Indian River Lagoon area.

4.4.8.8 *Natural Threats*

Herons, gulls, dogfish, and sharks prey upon hatchlings. Adults face predation primarily by sharks and to a lesser extent by killer whales. All sea turtles except leatherbacks can undergo "cold stunning" if water temperatures drop below a threshold level, which can be lethal. For unknown reasons, the frequency of a disease called fibropapillomatosis is much higher in green sea turtles than in other species and threatens a large number of existing subpopulations. Extremely high incidence has been reported in Hawaii, where affliction rates peaked at 47-69% in some foraging areas (Murakawa et al. 2000). A to-date unidentified virus may aid in the development of fibropapillomatosis (Work et al. 2009). Predators (primarily of eggs and hatchlings) also include dogs, pigs, rats, crabs, sea birds, reef fishes, and groupers (Bell et al. 1994; Witzell 1981). Green sea turtles with an abundance of barnacles have been found to have a much greater probability of having health issues (Flint et al. 2009).

4.4.8.9 *Anthropogenic Threats*

Major anthropogenic impacts to the nesting and marine environment affect green sea turtle survival and recovery. At nesting beaches, green sea turtles rely on intact dune structures, native vegetation, and normal beach temperatures for nesting (Ackerman 1997). Structural impacts to nesting habitat include the construction of buildings and pilings, beach armoring and renourishment, and sand extraction (Bouchard et al. 1998; Lutcavage et al. 1997b). These factors may directly, through loss of beach habitat, or indirectly, through changing thermal profiles and increasing erosion, serve to decrease the amount of nesting area available to nesting females, and may evoke a change in the natural behaviors of adults and hatchlings (Ackerman 1997; Witherington et al. 2003; Witherington et al. 2007). On the Pacific coast of Mexico in the mid-1970s, >70,000 green turtle eggs were harvested every night. The presence of lights on or adjacent to nesting beaches alters the behavior of nesting adults (Witherington 1992) and is often fatal to emerging hatchlings as they are attracted to light sources and drawn away from the water (Witherington and Bjorndal 1991). In addition to impacting the terrestrial zone, anthropogenic disturbances also threaten coastal marine habitats, particularly areas rich in seagrass and marine algae. These impacts include contamination from herbicides, pesticides, oil spills, and other chemicals, as well as structural degradation from excessive boat anchoring and dredging (Francour et al. 1999; Lee Long et al. 2000; Waycott et al. 2005). Ingestion of plastic and other marine debris is another source of morbidity and mortality (Stamper et al. 2009). Green sea turtles stranded in Brazil were all found to have ingested plastics or fishing debris (n=34), although mortality appears to have results in three cases (Tourinho et al. 2009). Low-level bycatch has also been documented in longline fisheries (Petersen et al. 2009). Further, the introduction of alien algae species threatens the stability of some coastal ecosystems and may lead to the elimination of preferred dietary species of green sea turtles (De Weede 1996). Very few green sea turtles are bycaught in U.S. fisheries (Finkbeiner et al. 2011). However, a legal fishery operates in Madagascar that harvested about 10,000 green turtles annually in the mid-1990s.

Sea level rise may have significant impacts upon green turtle nesting on Pacific atolls. These low-lying, isolated locations could be inundated by rising water levels associated with global warming, eliminating nesting habitat (Baker et al. 2006; Fuentes et al. 2010). Fuentes et al. (2010) predicted that rising temperatures would be a much greater threat in the long term to the hatching success of sea turtle turtles in general and green sea turtles along northeastern Australia particularly. Green sea turtles emerging from nests at cooler temperatures likely absorb more yolk that is converted to body tissue than do hatchlings from warmer nests (Ischer et al. 2009). Predicted temperature rises may approach or exceed the upper thermal tolerance limit of sea turtle incubation, causing widespread failure of nests (Fuentes et al. 2010). Although the timing of loggerhead nesting depends upon sea-surface temperature, green sea turtles do not appear to be affected (Pike 2009).

Green sea turtles have been found to contain the organochlorines chlordane, lindane, endrin, endosulfan, dieldrin, DDT and PCB (Gardner et al. 2003; Miao et al. 2001). Levels of PCBs found in eggs are considered far higher than what is fit for human consumption (van de Merwe et al. 2009). The heavy metals copper, lead, manganese, cadmium, and nickel have also been found in various tissues and life stages (Barbieri 2009). Arsenic also occurs in very high levels in green sea turtle eggs (van de Merwe et al. 2009). These contaminants have the potential to cause deficiencies in endocrine, developmental, and reproductive health, and depress immune function in loggerhead sea turtles (Keller et al. 2006a; Storelli et al. 2007c). Exposure to sewage effluent may also result in green sea turtle eggs harboring antibiotic-resistant strains of bacteria (Al-Bahry et al. 2009). DDE has not been found to influence sex determination at levels below cytotoxicity (Keller and McClellan-Green 2004; Podreka et al. 1998). To date, no tie has been found between pesticide concentration and susceptibility to fibropapillomatosis, although degraded habitat and pollution have been tied to the incidence of the disease (Aguirre et al. 1994; Foley et al. 2005). Flame retardants have been measured from healthy individuals (Hermanussen et al. 2008). It has been theorized that exposure to tumor-promoting compounds produced by the cyanobacteria *Lyngbya majuscule* could promote the development of fibropapillomatosis (Arthur et al. 2008). It has also been theorized that dinoflagellates of the genus *Prorocentrum* that produce the tumorogenic compound okadoic acid may influence the development of fibropapillomatosis (Landsberg et al. 1999).

4.4.8.10 ***Critical Habitat***

On September 2, 1998, critical habitat for green sea turtles was designated in coastal waters surrounding Culebra Island, Puerto Rico (63 FR 46693). Aspects of these areas that are important for green sea turtle survival and recovery include important natal development habitat, refuge from predation, shelter between foraging periods, and food for green sea turtle prey. The essential physical and biological features of this critical habitat include (1) seagrass beds, which provide valuable foraging habitat; (2) coastal waters of Culebra, which serve as a developmental habitat and support juvenile, subadult, and adult green sea turtle populations; and (3) coral reefs and other topographic features that provide shelter (FR 63 (170): 46693-46701, September 2, 1998).

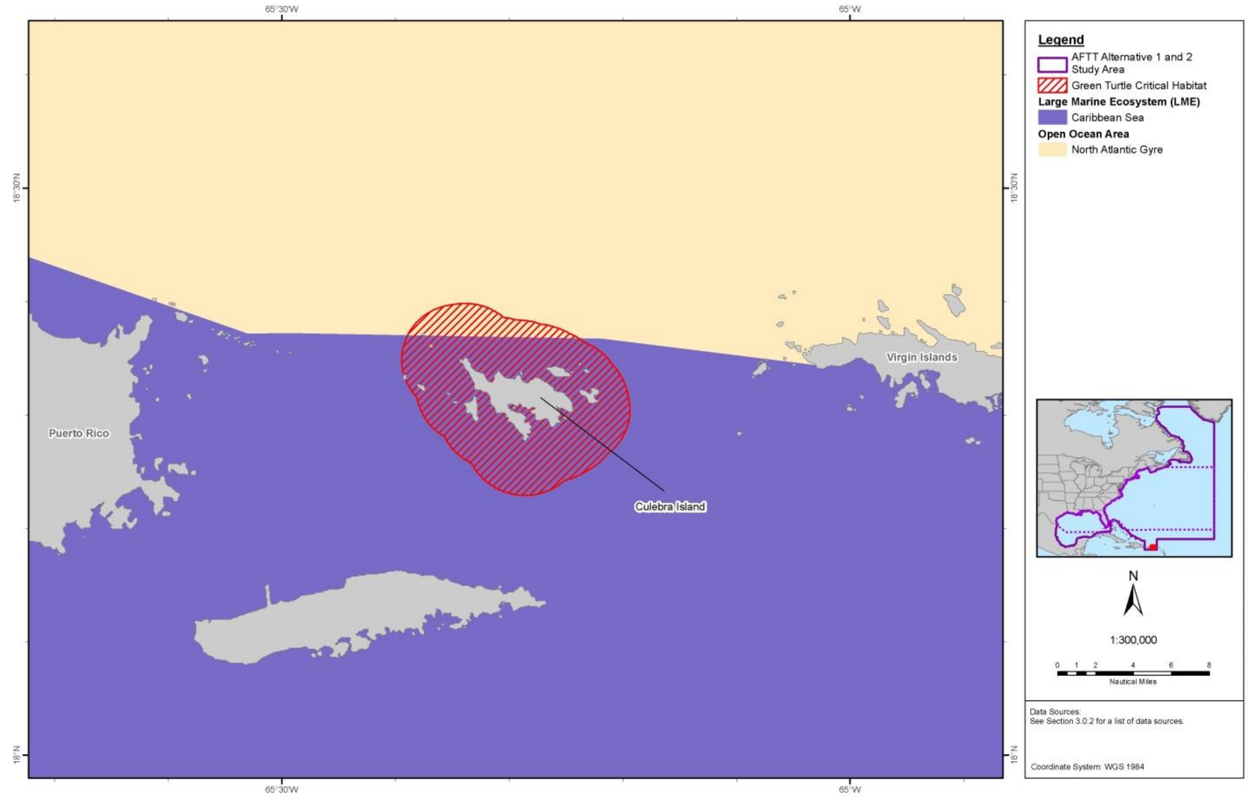

Figure 11. Green Sea Turtle Critical Habitat Within the AFTT Study Area

4.4.9 **Hawksbill Sea Turtle**

4.4.9.1 ***Population Designation***

Populations are distinguished generally by ocean basin and more specifically by nesting location. Our understanding of population structure is relatively poor. For example, genetic analysis of hawksbill sea turtles foraging off the Cape Verde Islands identified three closely-related haplotypes in a large majority of individuals sampled that did not match those of any known nesting population in the Western Atlantic, where the vast majority of nesting has been documented (McClellan et al. 2010; Monzon-Arguello et al. 2010).

4.4.9.2 ***Distribution***

The hawksbill has a circumglobal distribution throughout tropical and, to a lesser extent, subtropical waters of the Atlantic, Indian, and Pacific oceans. Satellite tagged turtles have shown significant variation in movement and migration patterns. In the Caribbean, distance traveled between nesting and foraging locations ranges from a few kilometers to a few hundred kilometers (Byles and Swimmer 1994; Hillis-Starr et al. 2000; Horrocks et al. 2001; Lagueux et al. 2003; Miller et al. 1998; Prieto et al. 2001).

4.4.9.3 ***Migration and Movement***

Upon first entering the sea, neonatal hawksbills in the Caribbean are believed to enter an oceanic phase that may involve long distance travel and eventual recruitment to nearshore foraging habitat (Boulon Jr. 1994). In the marine environment, the oceanic phase of juveniles (i.e., the "lost years") remains one of the most poorly understood aspects of hawksbill life history, both in terms of where turtles occur and how long they remain oceanic. Nesting site selection in the southwest Pacific appears to favor sites with higher wind and wave exposure, possibly as a means to aid hatchling dispersal (Garcon et al. 2010).

4.4.9.4 *Habitat*

Hawksbill sea turtles are highly migratory and use a wide range of broadly separated localities and habitats during their lifetimes (Musick and Limpus 1997b; Plotkin 2003). Small juvenile hawksbills (5-21 cm straight carapace length) have been found in association with *Sargassum* spp. in both the Atlantic and Pacific oceans (Musick and Limpus 1997b) and observations of newly hatched hawksbills attracted to floating weed have been made (Hornell 1927; Mellgren and Mann 1996; Mellgren et al. 1994). Post-oceanic hawksbills may occupy a range of habitats that include coral reefs or other hard-bottom habitats, sea grass, algal beds, mangrove bays and creeks (Bjorndal and Bolten 2010; Musick and Limpus 1997b), and mud flats (R. von Brandis, unpublished data in NMFS and USFWS 2007g). Eastern Pacific adult females have recently been tracked in saltwater mangrove forests along El Salvador and Honduras, a habitat that this species was not previously known to occupy (Gaos et al. 2011). Individuals of multiple breeding locations can occupy the same foraging habitat (Bass 1999; Bowen et al. 1996; Bowen et al. 2007; Diaz-Fernandez et al. 1999; Velez-Zuazo et al. 2008). As larger juveniles, some individuals may associate with the same feeding locality for more than a decade, while others apparently migrate from one site to another (Blumenthal et al. 2009; Mortimer et al. 2003; Musick and Limpus 1997b). Larger individuals may prefer deeper habitats than their smaller counterparts (Blumenthal et al. 2009). Nesting sites appear to be related to beaches with relatively high exposure to wind or wind-generated waves (Santana Garcon et al. 2010).

Hawksbill sea turtles appear to be rare visitors to the Gulf of Mexico, with Florida and Texas being the only Gulf states with regular sightings (Hildebrand 1983; Keinath et al. 1991; Lee and Palmer 1981; NMFS and USFWS 1993; Parker 1995; Plotkin 1995a; Rabalais and Rabalais 1980; Rester and Condrey 1996; Witzell 1983). The greatest hawksbill turtle numbers in the southeastern United States are found in the autumn off southern Florida, but can occur year-round (Musick and Limpus 1997a; NMFS and USFWS 2007b). Individuals stranded in Texas are generally young (hatchlings or yearlings) originating from Mexican nesting beaches (Amos 1989; Collard and Ogren 1990; Hildebrand 1983; Landry and Costa 1999).

Within United States territories and U.S. dependencies in the Caribbean Region, hawksbill sea turtles nest principally in Puerto Rico and the U.S. Virgin Islands, particularly on Mona Island and Buck Island. They also nest on other beaches on St. Croix, Culebra Island, Vieques Island, mainland Puerto Rico, St. John, and St. Thomas. Within the continental United States, hawksbill sea turtles nest only on beaches along the southeast coast of Florida and in the Florida Keys.

4.4.9.5 *Growth and Reproduction*

The best estimate of age at sexual maturity for hawksbill sea turtles is 20-40 years (Chaloupka and Limpus 1997; Crouse 1999). Reproductive females undertake periodic (usually non-annual) migrations to their natal beaches to nest. Movements of reproductive males are less well known, but are presumed to involve migrations to their nesting beach or to courtship stations along the migratory corridor (Meylan 1999). Females nest an average of 3-5 times per season (Meylan and Donnelly 1999; Richardson et al. 1999). Clutch size up to 250 eggs; larger than that of other sea turtles (Hirth 1980). Reproductive females may exhibit a high degree of fidelity to their nest sites.

The life history of hawksbills consists of a pelagic stage that lasts from hatching until they are approximately 22-25 cm in straight carapace length (Meylan 1988; Meylan and Donnelly 1999), followed by residency in coastal developmental habitats.

4.4.9.6 ***Vocalization and Hearing***

Sea turtles are low-frequency hearing specialists, typically hearing frequencies from 30 to 2,000 Hz, with a range of maximum sensitivity between 100 and 800 Hz (Bartol et al. 1999b; Lenhardt 2002; Lenhardt 1994; Moein Bartol and Ketten 2006; Ridgway et al. 1969). Hearing below 80 Hz is less sensitive but still possible (Lenhardt 1994).

These hearing sensitivities are similar to those reported for two terrestrial species: pond and wood turtles. Pond turtles respond best to sounds between 200 and 700 Hz, with slow declines below 100 Hz and rapid declines above 700 Hz, and almost no sensitivity above 3000 Hz (Wever and Vernon 1956). Wood turtles are sensitive up to about 500 Hz, followed by a rapid decline above 1000 Hz and almost no responses beyond 3000 or 4000 Hz (Patterson 1966).

4.4.9.7 ***Status and Trends***

Hawksbill sea turtles received protection on June 2, 1970 (35 FR 8495) under the Endangered Species Conservation Act and since 1973 have been listed as endangered under the ESA. Consideration of the status of populations outside of the action area is important under the present analysis to determine the riskto the affected population(s) bears on the status of the species as a whole. Although no historical records of abundance are known, hawksbill sea turtles are considered to be severely depleted due to the fragmentation and low use of current nesting beaches (NMFS and USFWS 2007g). Worldwide, an estimated 21,212-28,138 hawksbills nest each year among 83 sites. Among the 58 sites for with historic trends, all show a decline during the past 20 to 100 years. Among 42 sites for which recent trend data are available, 10 (24%) are increasing, three (7%) are stable and 29 (69%) are decreasing. Encouragingly, nesting range along Mexico and Central America appears not to have contracted and estimates continue to increase as additional dedicated study is conducted in the eastern Pacific (Gaos et al. 2010).

Atlantic Ocean. Atlantic nesting sites include: Antigua (Jumby Bay), the Turks and Caicos, Barbados, the Bahamas, Puerto Rico (Mona Island), the U.S. Virgin Islands, the Dominican Republic, Sao Tome, Guadaloupe, Trinidad and Tobago, Jamaica, Martinique, Cuba (Doce Leguas Cays), Mexico (Yucatan Peninsula), Costa Rica (Tortuguero National Park), Guatemala, Venezuela, Bijagos Archipelago, Guinea-Bissau, and Brazil.

Population increase has been greater in the Insular Caribbean than along the Western Caribbean Mainland or the eastern Atlantic (including Sao Tomé and Equatorial Guinea). Nesting populations of Puerto Rico appeared to be in decline until the early 1990s, but have universally increased during the survey periods. Mona Island now hosts 199-332 nesting females annually, and the other sites combined host 51-85 nesting females annually (R.P. van Dam and C.E. Diez, unpublished data in NMFS and USFWS 2007g) C.E. Diez, Chelonia, Inc., in litt. to J. Mortimer 2006). The U.S. Virgin Islands have a long history of tortoiseshell trade (Schmidt 1916). At Buck Island Reef National Monument, protection has been in force since 1988, and during that time, hawksbill nesting has increased by 143% to 56 nesting females annually, with apparent spill over to beaches on adjacent St. Croix (Z. Hillis-Starr, National Park Service, in litt. to J. Mortimer 2006). However, St. John populations did not increase, perhaps due to the proximity of the legal turtle harvest in the British Virgin Islands (Z. Hillis-Starr, National Park Service, in litt. to J. Mortimer 2006). Populations have also been identified in Belize and Brazil as genetically unique (Hutchinson and Dutton 2007). An estimated 50-200 nests are laid per year in the Guinea-Bissau (Catry et al. 2009).

4.4.9.8 *Natural Threats*

Sea turtles face predation primarily by sharks and to a lesser extent by killer whales. All sea turtles except leatherbacks can undergo "cold stunning" if water temperatures drop below a threshold level, which can be lethal. The only other significant natural threat to hawksbill sea turtles is from hybridization of hawksbills with other species of sea turtles. This is especially problematic at certain sites where hawksbill numbers are particularly low (Mortimer and Donnelly in review). Predators (primarily of eggs and hatchlings) include dogs, pigs, rats, crabs, sea birds, reef fishes, groupers, feral cats, and foxes (Bell et al. 1994; Ficetola 2008). In some areas, nesting beaches can be almost completely destroyed and all nests can sustain some level of depredation (Ficetola 2008).

4.4.9.9 *Anthropogenic Threats*

Threats to hawksbill sea turtles are largely anthropogenic, both historically and currently. Impacts to nesting beaches include the construction of buildings and pilings, beach armoring and renourishment, and sand extraction (Bouchard et al. 1998; Lutcavage et al. 1997b). Because hawksbills prefer to nest under vegetation (Horrocks and Scott 1991; Mortimer 1982), they are particularly impacted by beachfront development and clearing of dune vegetation (Mortimer and Donnelly in review). The presence of lights on or adjacent to nesting beaches alters the behavior of nesting adults (Witherington 1992) and is often fatal to emerging hatchlings as they are attracted to light sources and drawn away from the water (Witherington and Bjorndal 1991).

One of the most detrimental human threats to hawksbill sea turtles is the intensive harvest of eggs from nesting beaches. Between 1950 and 1992, approximately 1.3 million hawksbill shells were collected to supply tortoiseshell to the Japanese market, the world's largest. Before the U.S. certified Japan under the Pelly Amendment, Japan had been importing about 20 metric tons of hawksbill shell per year, representing approximately 19,000 turtles. Japan stopped importing tortoiseshell in 1993 in order to comply with CITES (Limpus and Miller 2008). Until recently, tens of thousands of hawksbills were captured and killed each year to meet demand for jewelry, ornamentation, and whole stuffed turtles (Eckert 1993b). In 1988, Japan's imports from Jamaica, Haiti and Cuba represented some 13,383 hawksbills: it is extremely unlikely that this volume could have originated solely from local waters (Eckert 1993b). Large numbers of nesting and foraging hawksbill sea turtles are captured and killed for trade in Micronesia, the Mexican Pacific coast, southeast Asia and Indonesia (NMFS and USFWS 1998b).

In addition to impacting the terrestrial zone, anthropogenic disturbances also threaten coastal marine habitats. These impacts include contamination from herbicides, pesticides, oil spills, and other chemicals, as well as structural degradation from excessive boat anchoring and dredging (Francour et al. 1999; Lee Long et al. 2000; Waycott et al. 2005). Hawksbills are typically associated with coral reefs, which are among the world's most endangered marine ecosystems (Wilkinson 2000). Although primarily spongivorous, bycatch of hawksbill sea turtles in the swordfish fishery off South Africa occurs (Petersen et al. 2009). Finkbeiner et al. (2011) estimated that annual bycatch interactions total at least 20 individuals annually for U.S. Atlantic fisheries (resulting in less than ten mortalities) and no or very few interactions in U.S. Pacific fisheries.

Future impacts from climate change and global warming may result in significant changes in hatchling sex ratios. The fact that hawksbill turtles exhibit temperature-dependent sex determination (Wibbels 2003) suggests that there may be a skewing of future hawksbill cohorts toward strong female bias (since warmer temperatures produce more female embryos).

4.4.9.10 ***Critical Habitat***

On September 2, 1998, the NMFS established critical habitat for hawksbill sea turtles around Mona and Monito Islands, Puerto Rico (63 FR 46693). Aspects of these areas that are important for hawksbill sea turtle survival and recovery include important natal development habitat, refuge from predation, shelter between foraging periods, and food for hawksbill sea turtle prey.

These critical habitat areas are shown in the figure below. Critical habitat includes (1) coral reefs for food and shelter and (2) nesting beaches. The essential physical and biological features of coral reefs support a large, long-term juvenile hawksbill population, in addition to subadults and adults. The types of sponges that hawksbills prefer are found on the reefs around these islands. Reef ledges and caves also provide resting areas and protection from predators. Nesting beaches on Mona Island support the largest population of nesting hawksbill turtles in the U.S. Caribbean (National Marine Fisheries Service and U.S. Fish and Wildlife Service 1998).

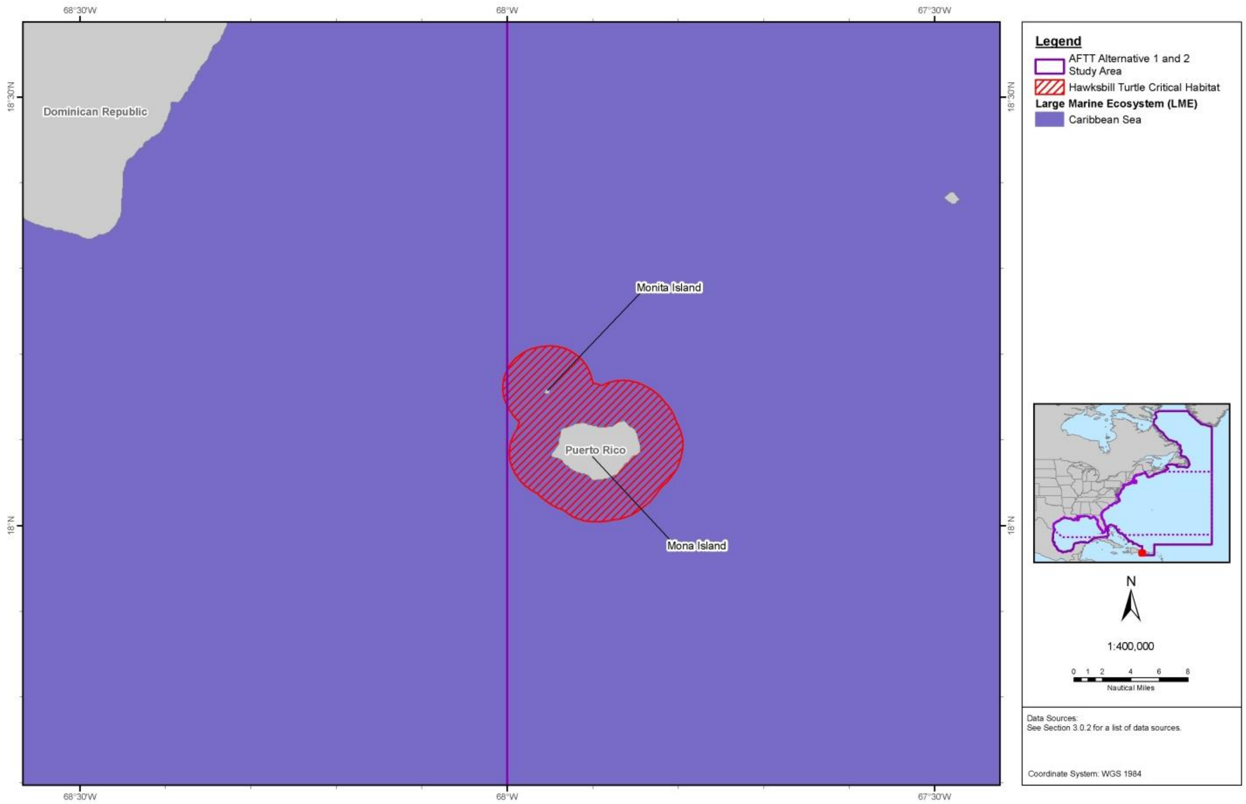

Figure 12. Critical Habitat for Hawksbill Sea Turtles in the AFTT Study Area

4.4.10 **Kemp's Ridley Sea Turtle**

4.4.10.1 ***Distribution***

The Kemp's ridley was formerly known only from the Gulf of Mexico and along the Atlantic coast of the U.S. (TEWG 2000b). However, recent records support Kemp's ridley sea turtles distribution extending into the Mediterranean Sea on occasion (Tomas and Raga 2008). The vast majority of individuals stem from breeding beaches at Rancho Nuevo on the Gulf of Mexico coast of Mexico.

4.4.10.2 ***Movement and Migration***

Tracking of post-nesting females from Rancho Nuevo and Texas beaches indicates that turtles move along coastal migratory corridors either to the north or south from the nesting beach (Byles 1989b; Byles and Plotkin 1994; Renaud 1995a; Renaud et al. 1996; Shaver 1999; Shaver 2002). These migratory corridors appear to extend throughout the coastal areas of the Gulf of Mexico and most turtles appear to travel in waters less than roughly 164 feet in depth. Turtles that headed north and east traveled as far as southwest Florida, whereas those that headed south and east traveled as far as the Yucatan Peninsula, Mexico (Morreale et al. 2007).

Kemp's ridleys in south Florida begin to migrate northward during spring. With each passing month, the waters to the north become warmer and turtles migrate further to Long Island Sound and even Nova Scotia in late summer (Bleakney 1955). During winter, individuals return south in response to local water temperatures; the turtles in the northernmost areas begin their southward movement first. By early November, turtles from New York and New Jersey merge with turtles from the Chesapeake Bay (Byles 1988; Keinath 1993; Lutcavage and Musick 1985; Renaud 1995a) and North Carolina inshore waters (Epperly et al. 1995a; Epperly et al. 1995b; Musick et al. 1994).

Following migration, Kemp's ridley sea turtles settle into resident feeding areas for several months (Byles and Plotkin 1994; Morreale et al. 2007). Females may begin returning along relatively shallow migratory corridors toward the nesting beach in the winter in order to arrive at the nesting beach by early spring.

During spring and summer, juvenile Kemp's ridleys occur in the shallow coastal waters of the northern Gulf of Mexico from south Texas to north Florida. In the fall, most Kemp's ridleys migrate to deeper or more southern warmer waters and remain there through the winter (Schmid 1998a). As adults, many turtles remain in the Gulf of Mexico, with only occasional occurrence in the Atlantic Ocean (NMFS et al. 2010). Satellite telemetry of males caught near Padre Island, Texas, indicates no migration, but year-round occurrence in nearshore waters less than 50 m (Shaver et al. 2005b). Many postnesting females from Rancho Nuevo migrate north to areas offshore of Texas and Louisiana (Marquez-M. 1994b). Farther south, some post-nesting females migrate from Rancho Nuevo to the northern and western Yucatán Peninsula in the southern Gulf of Mexico, which contains important seasonal foraging sites for adult females, such as the Bay of Campeche (Marquez-M. 1994b; Márquez 1990b; Pritchard and Marquez 1973).

4.4.10.3 ***Reproduction***

Mating is believed to occur about three to four weeks prior to the first nesting (Rostal 2007), or late March through early to mid-April. It is presumed that most mating takes place near the nesting beach (Morreale et al. 2007; Rostal 2007). Females initially ovulate within a few days after successful mating and lay the first clutch approximately two to four weeks later; if a turtle nests more than once per season, subsequent ovulations occur within approximately 48 hours after each nesting (Rostal 2007).

Approximately 60% of Kemp's ridley nesting occurs along an approximate 25-mile stretch of beach near Rancho Nuevo, Tamaulipas, Mexico from April to July, with limited nesting to the north (100 nests along Texas in 2006) and south (several hundred nests near Tampico, Mexico in 2006 USFWS 2006). Nesting at this location may be particularly important because hatchlings can more easily migrate to foraging grounds (Putman et al. 2010). The Kemp's ridley sea turtle tends to nest in large aggregations or arribadas (Bernardo and Plotkin 2007). The period between Kemp's ridley arribadas averages approximately 25 days, but the precise timing of the arribadas is unpredictable (Bernardo and Plotkin 2007; Rostal et al. 1997). Like all sea turtles, Kemp's ridley sea turtles nest multiple times in a single nesting season. The most recent analysis suggests approximately 3.075 nests per nesting season per female (Rostal 2007). The annual average number of eggs per nest (clutch size) is 94 to 100 and eggs typically take 45 to 58 days to hatch, depending on temperatures (Marquez-M. 1994a; Rostal 2007; USFWS 2000; USFWS 2001; USFWS 2002; USFWS 2003; USFWS 2004; USFWS 2005a; USFWS 2006). The period between nesting seasons for each female is approximately 1.8 to 2.0 years (Marquez et al. 1989; Rostal 2007; TEWG 2000b). The nesting beach at Rancho Nuevo may produce a "natural" hatchling sex ratio that is female-biased, which can potentially increase egg production as those turtles reach sexual maturity (Coyne and Landry Jr. 2007; Wibbels 2007).

4.4.10.4 ***Growth***

Kemp's ridleys require approximately 1.5 to two years to grow from a hatchling to a size of approximately 7.9 inches long, at which size they are capable of making a transition to a benthic coastal immature stage, but can range from one to four years or more (Caillouet et al. 1995; Ogren 1989; Schmid 1998b; Schmid and Witzell 1997b; Snover et al. 2007a; TEWG 2000b; Zug et al. 1997). Based on the size of nesting females, it is assumed that turtles must attain a size of approximately 23.6 inches long prior to maturing (Marquez-M. 1994a). Growth models based on mark-recapture data suggest that a time period of seven to nine years would be required for this growth from benthic immature to mature size (Schmid and Witzell 1997b; Snover et al. 2007a). Currently, age to sexual maturity is believed to range from approximately 10 to 17 years for Kemp's ridleys (Caillouet Jr. et al. 1995; Schmid and Witzell 1997a; Snover et al. 2007b; Snover et al. 2007a). However, estimates of 10 to 13 years predominate in previous studies (Caillouet et al. 1995; Schmid and Witzell 1997b; TEWG 2000b).

4.4.10.5 ***Habitat***

Stranding data indicate that immature turtles in this benthic stage are found in coastal habitats of the entire Gulf of Mexico and U.S. Atlantic coast (Morreale et al. 2007; TEWG 2000b). Developmental habitats for juveniles occur throughout the entire coastal Gulf of Mexico and U.S. Atlantic coast northward to New England (Morreale et al. 2007; Schmid 1998b; Wibbels et al. 2005). Key foraging areas in the Gulf of Mexico include Sabine Pass, Texas; Caillou Bay and Calcasieu Pass, Louisiana; Big Gulley, Alabama; Cedar Keys, Florida; and Ten Thousand Islands, Florida (Carr and Caldwell 1956; Coyne et al. 1995; Ogren 1989; Schmid 1998b; Schmid et al. 2002; Witzell et al. 2005a). Foraging areas studied along the Atlantic coast include Pamlico Sound, Chesapeake Bay, Long Island Sound, Charleston Harbor, and Delaware Bay. Near-shore waters of 120 feet or less provide the primary marine habitat for adults, although it is not uncommon for adults to venture into deeper waters (Byles 1989a; Mysing and Vanselous 1989; Renaud et al. 1996; Shaver et al. 2005a; Shaver and Wibbels 2007a).

Benthic coastal waters of Louisiana and Texas seem to be preferred foraging areas for Kemp’s ridley sea turtles (particularly passes and beachfronts), although individuals may travel along the entire coastal margin of the Gulf of Mexico (Landry and Costa 1999; Landry et al. 1996; Renaud 1995b). Sightings are less frequent during winter and spring, but this is likely due to lesser sighting effort during these times (Keinath et al. 1996; Shoop and Kenney 1992b).

4.4.10.6 ***Vocalization and Hearing***

Sea turtles are low-frequency hearing specialists, typically hearing frequencies from 30 to 2,000 Hz, with a range of maximum sensitivity between 100 and 800 Hz (Bartol et al. 1999b; Lenhardt 2002; Lenhardt 1994; Moein Bartol and Ketten 2006; Ridgway et al. 1969). Hearing below 80 Hz is less sensitive but still possible (Lenhardt 1994). Juvenile Kemp‘s ridleys can hear from 100 to 500 Hz, with a maximum sensitivity between 100 and 200 Hz at thresholds of 110 dB re 1 μPa (Moein Bartol and Ketten 2006).

These hearing sensitivities are similar to those reported for two terrestrial species: pond and wood turtles. Pond turtles respond best to sounds between 200 and 700 Hz, with slow declines below 100 Hz and rapid declines above 700 Hz, and almost no sensitivity above 3000 Hz (Wever and Vernon 1956). Wood turtles are sensitive up to about 500 Hz, followed by a rapid decline above 1000 Hz and almost no responses beyond 3000 or 4000 Hz (Patterson 1966).

4.4.10.7 ***Status and Trends***

The Kemp's ridley sea turtle was listed as endangered on December 2, 1970 (35 FR 18319). Internationally, the Kemp's ridley is considered the most endangered sea turtle (NRC 1990b; USFWS 1999).

During the mid-20th century, the Kemp's ridley was abundant in the Gulf of Mexico. Historic information indicates that tens of thousands of Kemp's ridleys nested near Rancho Nuevo, Mexico, during the late 1940s (Hildebrand 1963). From 1978 through the 1980s, arribadas were 200 turtles or less, and by 1985, the total number of nests at Rancho Nuevo had dropped to approximately 740 for the entire nesting season, or a projection of roughly 234 turtles (TEWG 2000b; USFWS and NMFS 1992). Beginning in the 1990s, an increasing number of beaches in Mexico were being monitored for nesting, and the total number of nests on all beaches in Tamaulipas and Veracruz in 2002 was over 6,000; the rate of increase from 1985 ranged from 14-16% (Heppell et al. 2005; TEWG 2000b; USFWS 2002). In 2006, approximately 7,866 nests were laid at Rancho Nuevo with the total number of nests for all the beaches in Mexico estimated at about 12,000 nests, which amounted to about 4,000 nesting females based upon three nests per female per season (Rostal 2007; Rostal et al. 1997; USFWS 2006). Considering remigration rates, the population included approximately 7,000 to 8,000 adult female turtles at that time (Marquez et al. 1989; Rostal 2007; TEWG 2000b). Most recently, the 2007 nesting season included an arribada of over 4,000 turtles over a three-day period at Rancho Nuevo (P. Burchfield, pers. comm. in NMFS and USFWS 2007c). The increased recruitment of new adults is illustrated in the proportion of first time nesters, which has increased from 6% in 1981 to 41% in 1994. Average population growth was estimated at 13% per year between 1991 and 1995 (TEWG 1998c). In 2008, there were 17,882 nests in Mexico (Gladys Porter Zoo 2008), and nesting in 2009 reached 21,144 {Burchfield, 2010 #151170}. Population modelling used by the TEWG (2000a) projected that Kemp's ridleys could reach the recovery plan's intermediate recovery goal of 10,000 nesters by the year 2015. Recent calculations of nesting females determined from nest counts show that the population trend is increasing towards that recovery goal, with an estimate of 4,047 nesters in 2006 and 5,500 in 2007 (NMFS and USFWS 2007d).

Nesting has also expanded geographically, with a headstart program reestablishing nesting on South Padre Island starting in 1978. Growth remained slow until 1988, when rates of return started to grow slowly (Shaver and Wibbels 2007b). Nesting rose from 6 in 1996 to 128 in 2007, 195 in 2008, and 197 in 2009. Texas nesting then experienced a decline similar to that seen in Mexico for 2010, with 140 nests (National Park Service data, http://www.nps.gov/pais/naturescience/strp.htm), but nesting rebounded in 2011 with a record 199 nests (National Park Service data, http://www.nps.gov/pais/naturescience/current-season.htm).

4.4.10.8 *Natural Threats*

Sea turtles face predation primarily by sharks and to a lesser extent by killer whales. All sea turtles except leatherbacks can undergo "cold stunning" if water temperatures drop below a threshold level, which can pose lethal effects. Kemp's ridley sea turtles are particularly prone to this phenomenon along Cape Cod (Innis et al. 2009). In the last five years (2006-2010), the number of cold-stunned turtles on Cape Cod beaches averaged 115 Kemp's ridleys.

4.4.10.9 *Anthropogenic Threats*

Population decline has been curtailed due to the virtual elimination of sea turtle and egg harvesting, as well as assistance in hatching and raising hatchlings (head-start). However, habitat destruction remains a concern in the form of bottom trawling and shoreline development. Trawling destroys habitat utilized by Kemp's ridley sea turtles for feeding and construction activities can produce hazardous runoff. Bycatch is also a source of mortality for Kemp's ridley sea turtles (McClellan et al. 2009). Finkbeiner et al. (2011) estimated that annual bycatch interactions total at least 98,300 individuals annually for U.S. Atlantic fisheries (resulting in 2,700 mortalities or more). The vast majority of fisheries interactions with sea turtles in the U.S. are either Kemp's ridley's or loggerhead sea turtles (Finkbeiner et al. 2011).

Toxin burdens in Kemp's ridley sea turtles include DDT, DDE, PCBs, PFOA, PFOS, chlordane, and other organochlorines (Keller et al. 2005; Keller et al. 2004a; Lake et al. 1994; Rybitski et al. 1995). These contaminants have the potential to cause deficiencies in endocrine, developmental and reproductive health, and are known to depress immune function in loggerhead sea turtles (Keller et al. 2006b; Storelli et al. 2007b). Along with loggerheads, Kemp's ridley sea turtles have higher levels of PCB and DDT than leatherback and green sea turtles (Pugh and Becker 2001a). Organochlorines, including DDT, DDE, DDD, and PCBs have been identified as bioaccumulative agents and in greatest concentration in subcutaneous lipid tissue (Rybitski et al. 1995). Concentrations ranged from 7.46 mu g/kg to 607 mu g/kg, with a mean of 252 mu g/kg in lipid tissue. Five PCB congeners composed most of the contaminants: 153/132, 138/158, 180, 118, and 187 in order of concentration. PCBs have also been identified in the liver, ranging in concentration from 272 ng/g to 655 ng/g of wet weight, values that are several fold higher than in other sea turtle species (Lake et al. 1994). However, concentrations are reportedly 5% of that which causes reproductive failure in snapping turtles. DDE was identified to range from 137 ng/g to 386 ng/g wet weight. Trans-nonachlor was found at levels between 129 ng/g and 275 ng/g wet weight. Blood samples may be appropriate proxies for organochlorines in other body tissues (Keller et al. 2004a).

Perfluorinated compounds in the forms of PFOA and PFOS have been identified in the blood of Kemp's ridley turtles at concentrations of 39.4 ng/mL and 3.57 ng/mL, respectively (Keller et al. 2005). PFCAs have also been detected. It is likely that age and habitat are linked to PFC bioaccumulation.

Oil can also be hazardous to Kemp's ridley turtles, with fresh oil causing significant mortality and morphological changes in hatchlings, but aged oil having no detectable effects (Fritts and McGehee 1981). Blood levels of metals are lower in Kemp's ridley sea turtles than in other sea turtles species or similar to them, with copper (215 ng/g to 1,300 ng/g), lead (0 to 34.3 ng/g), mercury (0.5 ng/g to 67.3 ng/g), silver (0.042 ng/g to 2.74 ng/g), and zinc (3,280 ng/g to 18,900 ng/g) having been identified (Innis et al. 2008; Orvik 1997). It is likely that blood samples can be used as an indicator of metal concentration. Mercury has been identified in all turtle species studied, but are generally an order of magnitude lower than toothed whales. The higher level of contaminants found in Kemp's ridley sea turtles are likely due to this species tendency to feed higher on the food chain than other sea turtles. Females from sexual maturity through reproductive life should have lower levels of contaminants than males because contaminants are shared with progeny through egg formation.

4.4.11 **Leatherback Sea Turtle**

4.4.11.1 ***Population Designations***

Leatherbacks break into four nesting aggregations: Pacific, Atlantic, and Indian oceans, and the Caribbean Sea. Detailed population structure is unknown, but is likely dependent upon nesting beach location.

Atlantic Ocean. Previous genetic analyses of leatherbacks using only mitochondrial DNA (mtDNA) resulted in an earlier determination that within the Atlantic basin there are at least three genetically different nesting populations: the St. Croix nesting population (U.S. Virgin Islands), the mainland nesting Caribbean population (Florida, Costa Rica, Suriname/French Guiana), and the Trinidad nesting population (Dutton et al. 1999). Further genetic analyses using microsatellite markers in nuclear DNA along with the mtDNA data and tagging data has resulted in Atlantic Ocean leatherbacks now being divided into seven groups or breeding populations: Florida, Northern Caribbean, Western Caribbean, Southern Caribbean/Guianas, West Africa, South Africa, and Brazil (TEWG 2007b). Leatherbacks nest along the east coast of Florida from March through June, from Brevard County south to Palm Beach County (NMFS and USFWS 2007e). Nesting in Puerto Rico begins around March and continues through August. Females remain in the general vicinity of the nesting habitat between nestings, with total residence in the nesting and inter-nesting habitat lasting up to 4 months (Eckert et al. 1989; Keinath and Musick 1993).

Caribbean Sea. Nesting occurs in Puerto Rico, St. Croix, Costa Rica, Panama, Colombia, Trinidad and Tobago, Guyana, Suriname, and French Guiana (Bräutigam and Eckert 2006a; Márquez 1990a; Spotila et al. 1996).

4.4.11.2 ***Distribution***

Leatherbacks range farther than any other sea turtle species, having evolved physiological and anatomical adaptations that allow them to exploit cold waters (Frair et al. 1972; Greer et al. 1973; USFWS 1995). High-latitude leatherback range includes in the Atlantic includes the North and Barents Seas, Newfoundland and Labrador , Argentina, and South Africa (Goff and Lien 1988; Hughes et al. 1998; Luschi et al. 2003; Luschi et al. 2006; Márquez 1990a; Threlfall 1978). Pacific ranges extend to Alaska, Chile, and New Zealand (Brito 1998; Gill 1997; Hodge and Wing 2000).

Leatherbacks also occur in Mediterranean and Indian Ocean waters (Casale et al. 2003; Hamann et al. 2006b). Associations exist with continental shelf and pelagic environments and sightings occur in offshore waters of 7-27˚ C (CETAP 1982b). Juvenile leatherbacks usually stay in warmer, tropical waters >21˚ C (Eckert 2002). Males and females show some degree of natal homing to annual breeding sites (James et al. 2005).

4.4.11.3 *Growth and Reproduction*

It has been thought that leatherbacks reach sexual maturity somewhat faster than other sea turtles (except Kemp's ridley), with an estimated range of 3-6 years (Rhodin 1985) to 13-14 years (Zug and Parham 1996). However, recent research suggests otherwise, with western North Atlantic leatherbacks possibly not maturing until as late as 29 years of age (Avens and Goshe 2007). Female leatherbacks nest frequently (up to 10 nests per year and about every 2-3 years). During each nesting, females produce 100 eggs or more per clutch and 700 eggs or more per nesting season (Schultz 1975). However, up to ~30% of the eggs can be infertile. Thus, the actual proportion of eggs that can result in hatchlings is less than this seasonal estimate. The eggs incubate for 55-75 days before hatching.

4.4.11.4 *Habitat*

Leatherbacks occur throughout marine waters, from nearshore habitats to oceanic environments (Grant and Ferrell 1993; Schroeder and Thompson 1987; Shoop and Kenney 1992a; Starbird et al. 1993). Movements are largely dependent upon reproductive and feeding cycles and the oceanographic features that concentrate prey, such as frontal systems, eddy features, current boundaries, and coastal retention areas (Benson et al. 2011; Collard 1990; Davenport and Balazs 1991; Frazier 2001; HDLNR 2002). Aerial surveys off the western U.S. support continental slope waters as having greater leatherback occurrence than shelf waters (Bowlby et al. 1994; Carretta and Forney 1993; Green et al. 1992; Green et al. 1993). Nesting sites appear to be related to beaches with relatively high exposure to wind or wind-generated waves (Santana Garcon et al. 2010).

Areas above 30º N in the Atlantic appear to be popular foraging locations (Fossette et al. 2009b). Northern foraging areas were proposed for waters between 35º and 50º N along North American, Nova Scotia, the Gulf of Saint-Laurent, in the western and northern Gulf Stream, the Northeast Atlantic, the Azores front and northeast of the Azores Islands, north of the Canary Islands. Southern foraging was proposed to occur between 5º and 15º N in the Mauritania upwelling, south of the Cape Verde islands, over the Guinea Dome area, and off Venezuela, Guyana and Suriname.

4.4.11.5 *Migration and Movement*

Leatherback sea turtles migrate throughout open ocean convergence zones and upwelling areas, along continental margins, and in archipelagic waters (Eckert 1998; Eckert 1999; Morreale et al. 1994). In a single year, a leatherback may swim more than 9,600 km to nesting and foraging areas throughout ocean basins (Benson et al. 2007a; Benson et al. 2007b; Eckert 1998; Eckert 2006; Eckert et al. 2006; Ferraroli et al. 2004; Hays et al. 2004; Sale et al. 2006). Much of this travel may be due to movements within current and eddy features, moving individuals along (Sale and Luschi 2009). Return to nesting beaches may be accomplished by a form of geomagnetic navigation and use of local cues (Sale and Luschi 2009). Leatherback females will either remain in nearshore waters between nesting events, or range widely, presumably to feed on available prey (Byrne et al. 2009; Fossette et al. 2009a).

Fossette et al. (2009b) identified three main migratory strategies in leatherbacks in the North Atlantic (almost all of studied individuals were female). One involved 12 individuals traveling to northern latitudes during summer/fall and returning to waters during winter and spring. Another strategy used by six individuals was similar to this, but instead of a southward movement in fall, individuals overwintered in northern latitudes (30-40º N, 25-30º W) and moved into the Irish Sea or Bay of Biscay during spring before moving south to between 5 and 10º in winter, where they remained or returned to the northwest Atlantic. A third strategy, which was followed by three females remaining in tropical waters for the first year subsequent to nesting and moving to northern latitudes during summer/fall and spending winter and spring in latitudes of 40-50º N.

Leatherbacks occur along the southeastern U.S. year-round, with peak abundance in summer (TEWG 2007a). In spring, leatherback sea turtles appear to be concentrated near the coast, while other times of the year they are spread out at least to the Gulf Stream. From August 2009 through August 2010 off Jacksonville, Florida, surveys sighted 48 leatherback sea turtles, while simultaneous vessel surveys sighted four leatherback sea turtles (Ramsey 2013).

Leatherback sea turtles feed, rest, and migrate regularly in the northern Gulf of Mexico, inhabiting deep offshore waters in the vicinity of DeSoto Canyon (Davis et al. 2000a; Landry and Costa 1999). Leatherback sea turtles feed in shallow waters on the continental shelf waters along the Florida Panhandle, the Mississippi River Delta, and the Texas coast on dense aggregations of (Collard 1990).

Satellite tracking data reveal that leatherback females leaving Mexican and Central American nesting beaches migrate towards the equator and into Southern Hemisphere waters, some passing the Galápagos Islands, and disperse south of 10º S (Dutton et al. 2006; Shillinger et al. 2010). However, observations of leatherbacks in the Galápagos Islands are rare (Zárate et al. 2010).

Nesting site selection in the southwest Pacific appears to favor sites with higher wind and wave exposure, possibly as a means to aid hatchling dispersal (Garcon et al. 2010). Individuals nesting in Malaysia undergo migrations to tropical feeding areas, taking 5-7 months to arrive there from nesting locations (Benson et al. 2011). Additional foraging occurs in temperate locations, including across the Pacific basin along the U.S. west coast; individuals take 10-12 months to migrate here (Benson et al. 2011). Individuals nesting during the boreal summer move to feeding areas in the North China Sea, while boreal winter nesters moved across the Equator to forage in the Southern Hemisphere (Benson et al. 2011).

4.4.11.6 ***Sex Ratio***

A significant female bias exists in all leatherback populations thus far studied. An examination of strandings and in-water sighting data from the U.S. Atlantic and Gulf of Mexico coasts indicates that 60% of individuals were female. Studies of Suriname nesting beach temperatures suggest a female bias in hatchlings, with estimated percentages of females hatched over the course of each season at 75.4, 65.8, and 92.2% in 1985, 1986, and 1987, respectively (Plotkin 1995b). Binckley et al. (1998) found a heavy female bias upon examining hatchling gonad histology on the Pacific coast of Costa Rica, and estimated male to female ratios over three seasons of 0:100, 6.5:93.5, and 25.7:74.3. James et al. (2007) also found a heavy female bias (1.86:1) as well as a primarily large sub-adult and adult size distribution. Leatherback sex determination is affected by nest temperature, with higher temperatures producing a greater proportion of females (Mrosovsky 1994; Witzell et al. 2005b).

4.4.11.7 *Vocalization and Hearing*

Sea turtles are low-frequency hearing specialists, typically hearing frequencies from 30 to 2,000 Hz, with a range of maximum sensitivity between 100 and 800 Hz (Bartol et al. 1999b; Lenhardt 2002; Lenhardt 1994; Moein Bartol and Ketten 2006; Ridgway et al. 1969). Hearing below 80 Hz is less sensitive but still possible (Lenhardt 1994).

These hearing sensitivities are similar to those reported for two terrestrial species: pond and wood turtles. Pond turtles respond best to sounds between 200 and 700 Hz, with slow declines below 100 Hz and rapid declines above 700 Hz, and almost no sensitivity above 3000 Hz (Wever and Vernon 1956). Wood turtles are sensitive up to about 500 Hz, followed by a rapid decline above 1000 Hz and almost no responses beyond 3000 or 4000 Hz (Patterson 1966).

4.4.11.8 *Status and Trends*

Leatherback sea turtles received protection on June 2, 1970 (35 FR 8491) under the Endangered Species Conservation Act and, since 1973, have been listed as endangered under the ESA, but declines in nesting have continued worldwide. Consideration of the status of populations outside of the action area is important under the present analysis to determine the riskto the affected population(s) bears on the status of the species as a whole. Breeding females were initially estimated at 29,000-40,000, but were later refined to ~115,000 (Pritchard 1971; Pritchard 1982). Spotila et al. (1996) estimated 34,500 females, but later issued an update of 35,860 (Spotila 2004a). The species as a whole is declining and local populations are in danger of extinction (NMFS 2001a; NMFS 2001b).

Nesting aggregations occur along Gabon, Sao Tome and Principe, French Guiana, Suriname, and Florida (Bräutigam and Eckert 2006a; Márquez 1990a; Spotila et al. 1996). Widely dispersed but fairly regular African nesting also occurs between Mauritania and Angola (Fretey et al. 2007). Many sizeable populations (perhaps up to 20,000 females annually) of leatherbacks are known to nest in West Africa (Fretey 2001a). The population of leatherbacks nesting on Gabon beaches has been suggested as being the world’s largest, with 36,185-126,480 clutches being laid by 5,865-20,499 females annually from 2002-2007 (Witt et al. 2009). The total number of females utilizing Gabon nesting beaches is estimated to be 15,730- 41,373 (Witt et al. 2009). North Atlantic leatherbacks likely number 34,000-94,000 individuals, with females numbering 18,800 and the eastern Atlantic segment numbering 4,700 (TEWG 2007b). Trends and numbers include only nesting females and are not a complete demographic or geographic cross-section. In 1996, the entire Western Atlantic population was characterized as stable at best (Spotila et al. 1996), with roughly 18,800 nesting females. A subsequent analysis indicated that by 2000, the western Atlantic nesting population had decreased to about 15,000 nesting females (NMFS 2011). Spotila et al. (1996) estimated that the entire Atlantic basin, including all nesting beaches in the Americas, the Caribbean, and West Africa, totaled approximately 27,600 nesting females, with an estimated range of 20,082-35,133. This is consistent with other estimates of 34,000-

95,000 total adults (20,000-56,000 adult females; 10,000-21,000 nesting females)(TEWG 2007a).

The largest nesting aggregation in the western North Atlantic occurs in French Guiana and Suriname, likely belongs to a metapopulation whose limits remain unknown (Rivalan et al. 2006). Heppell et al. (2003a) concluded that leatherbacks generally show less genetic structuring than green and hawksbill sea turtles. The French Guiana nesting aggregation has declined ~15% annually since 1987 (NMFS 2001b). However, from 1979-1986, the number of nests increased ~15% annually, possibly indicating the current decline may be linked with the erosion cycle of Guiana beaches (NMFS 2006e). Guiana nesting may have increased again in the early 2000s (NMFS 2006e). Suriname nesting numbers have recently increased from more than 10,000 nests annually since 1999 and a peak of 30,000 nests in 2001. Overall, Suriname and French Guiana nesting trends towards an increase (Girondot et al. 2007; Hilterman and Goverse 2003). Florida (March-July) and U.S. Caribbean nesting since the early 1980s has increased ~0.3% and 7.5% per year, respectively, but lags behind the French Guiana coast and elsewhere in magnitude (NMFS/SEFSC 2001). This positive growth was seen within major nesting areas for the stock, including Trinidad, Guyana, and the combined beaches of Suriname and French Guiana (TEWG 2007a). Using both Bayesian modeling and regression analyses, the TEWG (2007a) determined that the Southern Caribbean/Guianas stock had demonstrated a long-term, positive population growth rate (using nesting females as a proxy for population).

The Caribbean coast of Costa Rica and extending through Chiriquí Beach, Panama, represents the fourth largest known leatherback rookery in the world (Troeng et al. 2004). Examination of data from three index nesting beaches in the region (Tortuguero, Gandoca, and Pacuare in Costa Rica) using various Bayesian and regression analyses indicated that the nesting population likely was not growing during 1995-2005 (TEWG 2007a). Other modeling of the nesting data for Tortuguero indicates a 67.8% decline between 1995 and 2006 (Troëng et al. 2007).

In Puerto Rico, the primary nesting beaches are at Fajardo and on the island of Culebra. Nesting between 1978 and 2005 ranged between 469-882 nests, and the population has been growing since 1978, with an overall annual growth rate of 1.1% (TEWG 2007a). At the primary nesting beach on St. Croix, the Sandy Point National Wildlife Refuge, nesting has fluctuated from a few hundred nests to a high of 1,008 in 2001, and the average annual growth rate has been approximately 1.1% from 1986-2004 (TEWG 2007a).

The Florida nesting stock comes ashore primarily along the east coast of Florida. This stock is of growing importance, with total nests between 800-900 per year in the 2000s following nesting totals fewer than 100 nests per year in the 1980s (NMFS 2011). Using data from the index nesting beach surveys, the TEWG (2007a) estimated a significant annual nesting growth rate of 1% between 1989 and 2005. Stewart et al. (2011) evaluated nest counts from 68 Florida beaches over 30 years (1979-2008) and found that nesting increased at all beaches with trends ranging from 3.1%-16.3% per year, with an overall increase of 10.2% per year. In 2007, a record 517 leatherback nests were observed on the index beaches in Florida, with 265 in 2008, and then an increase to a new record of 615 nests in 2009, and a slight decline in 2010 back to 552 nests

(FWC Index Nesting Beach database). This up-and-down pattern is thought to be a result of the cyclical nature of leatherback nesting, similar to the biennial cycle of green turtle nesting.

The most recent population estimate for leatherback sea turtles from the North Atlantic as a whole is between 34,000-90,000 adult individuals (20,000-56,000 adult females)(TEWG 2007a).

Heavy declines have occurred at all major Pacific basin rookeries, as well as Mexico, Costa Rica, Malaysia, India, Sri Lanka, Thailand, Trinidad, Tobago, and Papua New Guinea. This includes a nesting decline of 23% between 1984-1996 at Mexiquillo, Michoacán, Mexico (Sarti et al. 1996). According to reports from the late 1970s and early 1980s, three beaches on the Pacific coast of Mexico supported as many as half of all leatherback turtle nests for the eastern Pacific. Since the early 1980s, the eastern Pacific Mexican population of adult female leatherback turtles has declined to slightly more than 200 individuals during 1998-1999 and 1999-2000 (Sarti et al. 2000). Spotila et al. (2000) reported the decline of the leatherback turtle population at Playa Grande, Costa Rica, which had been the fourth largest nesting colony in the world. Between 1988 and 1999, the nesting colony declined from 1,367 to 117 female leatherback turtles. Based on their models, Spotila et al. (2000) estimated that the colony could fall to less than 50 females by 2003-2004. Fewer than 1,000 females nested on the Pacific coast of Mexico from 1995-1996 and fewer than 700 females are estimated for Central America (Spotila et al. 2000). The number of leatherback turtles nesting in Las Baulas National Park declined rapidly during the 1990s, from about 1,500 females during the 1988–89 nesting season, to about 800 in 1990–91 and 1991–92 to 193 in 1993–94 (Williams et al. 1996) and 117 in 1998–99 (Spotila et al. 2000). Spotila (2004b) reported that between 59 and 435 leatherbacks nest at Las Baulas each year depending on the El Niño–La Niña cycle. Only an Indonesian nesting assemblage has remained relatively abundant in the Pacific basin. The largest extant leatherback nesting assemblage in the Indo-Pacific lies on the northern Vogelkop coast of Irian Jaya (West Papua), Indonesia, with roughly 3,000 nests recorded annually (Putrawidjaja 2000; Suárez et al. 2000) (Dutton et al. 2007). The Western Pacific leatherback metapopulation harbors the last remaining nesting aggregation of significant size in the Pacific with approximately 2700–4500 breeding females (Dutton et al. 2007; Hitipeuw et al. 2007). The total number of nests per year for the Jamursba-Medi leatherback nesting population ranged between a high of 6,373 nests in 1996 and a low of 1,537 nests in 2010 (Hitipeuw et al. 2007).

Declines in the western Pacific is equally severe. Nesting at Terengganu, Malaysia is 1% of that in 1950s (Chan and Liew 1996). The South China Sea and East Pacific nesting colonies have undergone catastrophic collapse. Overall, Pacific populations have declined from an estimated 81,000 individuals to <3,000 total adults and subadults (Spotila et al. 2000). The number of nesting leatherbacks has declined by an estimated 95% over the past 20 years in the Pacific (Gilman 2009). Drastic overharvesting of eggs and mortality from fishing activities is likely responsible for this tremendous decline (Eckert 1997; Sarti et al. 1996).

Based on the survey and tagging work, it was estimated that 400-500 female leatherbacks nest annually on Great Nicobar Island (Andrews et al. 2002). The number of nesting females using the Andaman and Nicobar Islands combined was estimated around 1,000 (Andrews and Shanker 2002).

4.4.11.9 *Natural Threats*

Sea turtles face predation primarily by sharks and to a lesser extent by killer whales (Pitman and Dutton 2004). Hatchlings are preyed upon by herons, gulls, dogfish, and sharks. Leatherback hatching success is particularly sensitive to nesting site selection, as nests that are overwashed have significantly lower hatching success and leatherbacks nest closer to the high-tide line than other sea turtle species (Caut et al. 2009b).

4.4.11.10 *Anthropogenic Threats*

Leatherback nesting and marine environments are facing increasing impacts through widespread development and tourism along nesting beaches (Hamann et al. 2006b; Hernandez et al. 2007; Maison 2006; Santidrián Tomillo et al. 2007). Structural impacts to beaches include building and piling construction, beach armoring and renourishment, and sand extraction (Bouchard et al. 1998; Lutcavage et al. 1997b). In some areas, timber and marine debris accumulation as well as sand mining reduce available nesting habitat (Bourgeois et al. 2009; Chacón Chaverri 1999; Formia et al. 2003; Laurance et al. 2008). Lights on or adjacent to nesting beaches alter nesting adult behavior and is often fatal to emerging hatchlings as they are drawn to light sources and away from the sea (Bourgeois et al. 2009; Cowan et al. 2002; Deem et al. 2007; Witherington 1992; Witherington and Bjorndal 1991). Plastic ingestion is very common in leatherbacks and can block gastrointestinal tracts leading to death (Mrosovsky et al. 2009). Along the coast of Peru, 13% of 140 leatherback carcasses were found to contain plastic bags and film (Fritts 1982). Although global warming may expand foraging habitats into higher latitude waters, increasing temperatures may increase feminization of nests (Hawkes et al. 2007b; James et al. 2006; McMahon and Hays 2006; Mrosovsky et al. 1984). Rising sea levels may also inundate nests on some beaches. Egg collection is widespread and attributed to catastrophic declines, such as in Malaysia. Harvest of females along nesting beaches is of concern worldwide.

Bycatch, particularly by longline fisheries, is a major source of mortality for leatherback sea turtles (Crognale et al. 2008; Fossette et al. 2009a; Gless et al. 2008; Petersen et al. 2009). Wallace et al. (2010) estimated that between 1990 and 2008, at least 85,000 sea turtles were captured as bycatch in fisheries worldwide. This estimate is likely at least two orders of magnitude low, resulting in a likely bycatch of nearly half a million sea turtles annually (Wallace et al. 2010); many of these turtles are expected to be leatherbacks.

Spotila (2000) concluded that a conservative estimate of annual leatherback fishery-related mortality (from longlines, trawls and gillnets) in the Pacific Ocean during the 1990s is 1,500 animals. He estimates that this represented about a 23% mortality rate (or 33% if most mortality was focused on the East Pacific population). In the Pacific Ocean, between 1,000 and 1,300 leatherback sea turtles are estimated to have been captured and killed in longline fisheries in 2000 (Lewison et al. 2004). Shallow-set longline fisheries based out of Hawaii are estimated to have captured and killed several hundred leatherback sea turtles before they were closed in 2001. When they were re-opened in 2004, with substantial modifications to protect sea turtles, these fisheries were estimated to have captured and killed about 1 or 2 leatherback sea turtles each year. Between 2004 and 2008, shallow-set fisheries based out of Hawaii are estimated to have captured about 19 leatherback sea turtles, killing about 5 of these sea turtles.

Donoso and Dutton (2010) found that 284 leatherbacks were bycaught between 2001 and 2005 as part of the Chilean longline fishery, with two individuals observed dead; leatherbacks were the most frequently bycaught sea turtle species. Between 8-17 leatherback turtles likely died annually between 1990 and 2000 in interactions with the California/Oregon drift gillnet fishery; 500 leatherback turtles are estimated to die annually in Chilean and Peruvian fisheries; 200 leatherback turtles are estimated to die in direct harvests in Indonesia; and, before 1992, the North Pacific driftnet fisheries for squid, tuna, and billfish captured an estimated 1,000 leatherback turtles each year, killing about 111 of them each year. Currently, the U.S. tuna and swordfish longline fisheries managed under the HMS FMP are estimated to capture 1,764 leatherbacks (no more than 252 mortalities) for each 3-year period starting in 2007 (NMFS 2004b). In 2010, there were 26 observed interactions between leatherback sea turtles and longline gear used in the HMS fishery (Garrison and Stokes 2011). All leatherbacks were released alive, with all gear removed for the majority of captures. While 2010 total estimates are not yet available, in 2009, 285.8 (95% CI: 209.6-389.7) leatherback sea turtles are estimated to have been taken in the longline fisheries managed under the HMS FMP based on the observed takes (Garrison and Stokes 2010). Finkbeiner et al. (2011) estimated hundreds of interactions in U.S. Pacific fisheries (resulting in about 10 mortalities).

We know little about the effects of contaminants on leatherback sea turtles. The metals arsenic, cadmium, copper, mercury, selenium, and zinc bioaccumulate, with cadmium in highest concentration in leatherbacks versus any other marine vertebrate (Caurant et al. 1999; Gordon et al. 1998). A diet of primarily jellyfish, which have high cadmium concentrations, is likely the cause (Caurant et al. 1999). Organochlorine pesticides have also been found (McKenzie et al. 1999). PCB concentrations are reportedly equivalent to those in some marine mammals, with liver and adipose levels of at least one congener being exceptionally high (PCB 209: 500-530 ng/g wet weight Davenport et al. 1990; Oros et al. 2009).

4.4.11.11 ***Critical Habitat***

On March 23, 1979, leatherback critical habitat (See Figure Below) was identified adjacent to Sandy Point, St. Croix, U.S.V.I. from the 183 m isobath to mean high tide level between 17° 42’12” N and 65°50’00” W (44 FR 17710). This habitat is essential for nesting, which has been increasingly threatened since 1979, when tourism increased significantly, bringing nesting habitat and people into close and frequent proximity. However, studies do not currently support significant critical habitat deterioration.

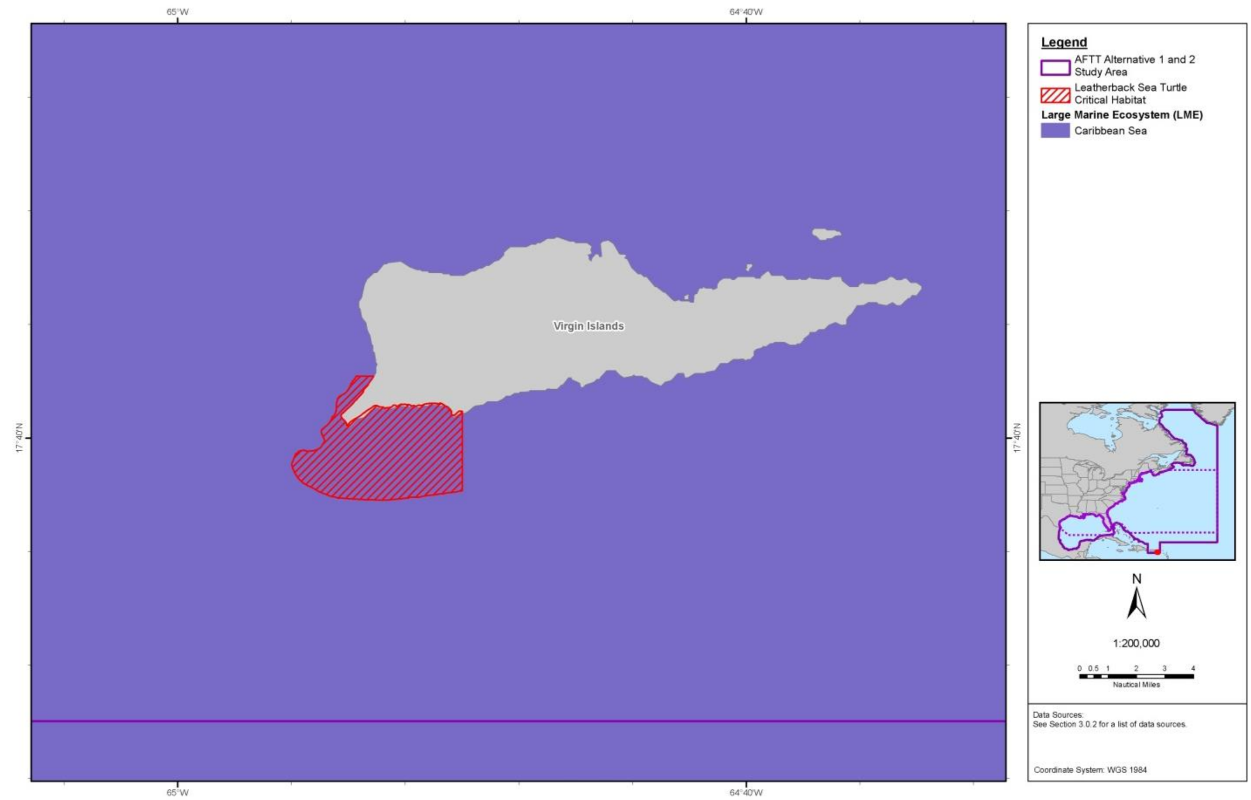

Figure 13. Critical Habitat for Leatherback Sea Turtles in the AFTT Study Area

On January 26, 2012, the NMFS designated critical habitat for leatherback sea turtles in waters along Washington State and Oregon (Cape Flattery to Cape Blanco; 64,760 km^2) and California (Point Arena to Point Arguello; 43,798 km^2). The areas do not overlap any portion of the AFTT Study Area. The primary constituent element of these areas includes the occurrence of prey species, primarily scyphomedusae of the order Semaeostomeae (*Chrysaora, Aurelia, Phacellophora,* and *Cyanea*), of sufficient condition, distribution, diversity, abundance and density necessary to support individual as well as population growth, reproduction, and development of leatherbacks.

4.4.12 **Loggerhead Sea Turtle – Northwest Atlantic Ocean DPS**

4.4.12.1 ***Population Designations***

Five groupings represent loggerhead sea turtles by major sea or ocean basin: Atlantic, Pacific, and Indian oceans, as well as Caribbean and Mediterranean seas. As with other sea turtles, populations are frequently divided by nesting aggregation (Hutchinson and Dutton 2007). On September 22, 2011, the NMFS designated nine distinct population segments (DPSs) of loggerhead sea turtles: South Atlantic Ocean and southwest Indian Ocean as threatened as well as Mediterranean Sea, North Indian Ocean, North Pacific Ocean, northeast Atlantic Ocean, northwest Atlantic Ocean, South Pacific Ocean, and southeast Indo-Pacific Ocean as endangered (75 FR 12598).

Atlantic Ocean. Western Atlantic nesting locations include The Bahamas, Brazil, and numerous locations from the Yucatán Peninsula to North Carolina (Addison 1997; Addison and Morford 1996; Marcovaldi and Chaloupka 2007). This group comprises five nesting subpopulations: Northern, Southern, Dry Tortugas, Florida Panhandle, and Yucatán. Additional nesting occurs on Cay Sal Bank (Bahamas), Cuba, the Bahamian Archipelago, Quintana Roo (Yucatan Peninsula), Colombia, Brazil, Caribbean Central America, Venezuela, and the eastern Caribbean Islands. Genetic studies indicate that, although females routinely return to natal beaches, males may breed with females from multiple populations and facilitate gene flow Bowen et al. (2005). In the eastern Atlantic, we know of five rookeries from Cape Verde, Greece, Libya, Turkey, and the western Africa coast.

4.4.12.2 *Reproduction and Growth*

Loggerhead nesting is confined to lower latitudes temperate and subtropic zones but absent from tropical areas (NMFS and USFWS 1991b; NRC 1990a; Witherington et al. 2006b). The life cycle of loggerhead sea turtles can be divided into seven stages: eggs and hatchlings, small juveniles, large juveniles, subadults, novice breeders, first year emigrants, and mature breeders (Crouse et al. 1987). Hatchling loggerheads migrate to the ocean (to which they are drawn by near ultraviolet light Kawamura et al. 2009), where they are generally believed to lead a pelagic existence for as long as 7-12 years (NMFS 2005b). Based on growth rate estimates, the duration of the open-ocean juvenile stage for North Atlantic loggerhead sea is roughly 8.2 years (Bjorndal et al. 2000b). Loggerheads in the Mediterranean, similar to those in the Atlantic, grow at roughly 11.8 cm/yr for the first six months and slow to roughly 3.6 cm/yr at age 2.5-3.5. As adults, individuals may experience a secondary growth pulse associated with shifting into neritic habitats, although growth is generally monotypic (declines with age Casale et al. 2009a; Casale et al. 2009b). Individually-based variables likely have a high impact on individual-to-individual growth rates (Casale et al. 2009b). At 15-38 years, loggerhead sea turtles become sexually mature, although the age at which they reach maturity varies widely among populations (Casale et al. 2009b; Frazer and Ehrhart 1985a; Frazer et al. 1994; NMFS 2001a; Witherington et al. 2006). However, based on new data from tag returns, strandings, and nesting surveys, NMFS (2001a) estimated ages of maturity ranging from 20-38 years and a benthic immature stage lasting from 14-32 years.

Loggerhead mating likely occurs along migration routes to nesting beaches, as well as offshore from nesting beaches several weeks prior to the onset of nesting (Dodd 1988a; NMFS and USFWS 1998d). Females usually breed every 2-3 years, but can vary from 1-7 years (Dodd 1988a; Richardson et al. 1978). Females lay an average of 4.1 nests per season (Murphy and Hopkins 1984) , although recent satellite telemetry from nesting females along southwest Florida support 5.4 nests per female per season, with increasing numbers of eggs per nest during the course of the season (Tucker 2009). The authors suggest that this finding warrants revision of the number of females nesting in the region. The western Atlantic breeding season is March-August. Nesting sites appear to be related to beaches with relatively high exposure to wind or wind-generated waves (Santana Garcon et al. 2010).

The Japanese rookeries are the most significant nesting sites for loggerheads in the North Pacific, with nesting occurring on the Japanese mainland, except for Hokkaido, as well as the Ryukyu

Islands to the south (Kamezaki 1989; Kamezaki et al. 2003; Sea Turtle Association of Japan 2010; Uchida and Nishiwaki 1995). Nesting generally occurs through summer and fall (April-August, peaking in July), with females returning every two to three years (Iwamoto et al. 1985). Nesting females lay at least three nests of 60-115 eggs per nest each season, with roughly two weeks between nests (Eckert 1993a; Iwamoto et al. 1985; Nishimura 1994). Between nests, females appear to swim offshore into the Kuroshio Current, possibly to speed egg development (NMFS and USFWS 1998c; Sato et al. 1998).

Nesting in the Gulf of Mexico does occur, although primarily in Florida, with rare nesting along North and South Padre Island in Texas from April through September, with a peak in June and July (Dodd 1988b; Dodd Jr. 1988; Hildebrand 1983; Weishampel et al. 2006; Williams-Walls et al. 1983).

4.4.12.3 *Migration and Movement*

Loggerhead hatchlings migrate offshore and become associated with *Sargassum* spp. habitats, driftlines, and other convergence zones (Carr 1986). After 14-32 years of age, they shift to a benthic habitat, where immature individuals forage in the open ocean and coastal areas along continental shelves, bays, lagoons, and estuaries (Bowen et al. 2004; NMFS 2001a). Adult loggerheads make lengthy migrations from nesting beaches to foraging grounds (TEWG 1998b). In the Gulf of Mexico, larger females tend to disperse more broadly after nesting than smaller individuals, which tend to stay closer to the nesting location (Girard et al. 2009). In the North Atlantic, loggerheads travel north during spring and summer as water temperatures warm and return south in fall and winter, but occur offshore year-round assuming adequate temperature. As water temperatures drop from October to December, most loggerheads emigrate from their summer developmental habitats to warmer waters south of Cape Hatteras, where they winter (Morreale and Standora 1998). For immature individuals, this movement occurs in two patterns: a north-south movement over the continental shelf with migration south of Cape Hatteras in winter and movement north along Virginia for summer foraging, and a not-so-seasonal oceanic dispersal into the Gulf Stream as far north as the 10-15˚ C isotherm (Mansfield et al. 2009). Wallace et al. (2009) suggested differences in growth rate based upon these foraging strategies. Long Island Sound, Core Sound, Pamlico Sound, Cape Cod Bay, and Chesapeake Bay are the most frequently used juvenile developmental habitats along the Northeast United States Continental Shelf Large Marine Ecosystem (Burke et al. 1991; Delannoy et al. 2013; Epperly et al. 1995a; Epperly et al. 1995b; Epperly et al. 1995c; Hoffman et al. 2013; Mansfield 2006). There is conflicting evidence that immature loggerheads roam the oceans in currents and eddies and mix from different natal origins or distribute on a latitudinal basis that corresponds with their natal beaches (Monzon-Arguello et al. 2009; Wallace et al. 2009). McCarthy et al. (2010) found that movement patterns of loggerhead sea turtles were more convoluted when sea surface temperatures were higher, ocean depths shallower, ocean currents stronger, and chlorophyll a levels lower.

Aerial surveys sponsored by the U.S. Navy January to August 2009 sighted 193 loggerhead turtles off the coast of Jacksonville, Florida, while line-transect surveys off North Carolina during the same period sighted 41 loggerhead sea turtles (Arbelo et al. 2012). Aerial observations in Onslow Bay from August 2009 through August 2010 sighted 495 loggerhead sea turtles, while vessel surveys during the same period sighted 47 loggerhead sea turtles (Ramsey 2013). Aerial surveys conducted between August 2009 and August 2010 off Jacksonville, Florida, sighted 716 loggerhead sea turtles, while vessel surveys during the same period sighted 47 loggerhead sea turtles (Ramsey 2013).

Individuals in the western Pacific also show wide-ranging movements. Loggerheads hatched on beaches in the southwest Pacific have been found to range widely in the southern portion of the basin, with individuals from populations nesting in Australia found as far east as Peruvian coast foraging areas still in the juvenile stage (Boyle et al. 2009). Individuals hatched along Japanese coasts have been found to migrate to waters off Baja California via the North Pacific Subtropical Gyre (and the Kuroshio Extension) to feed for several years before migrating back to western Pacific waters to breed (Bowen et al. 1995; Nichols 2005; Polovina et al. 2006; Polovina et al. 2000; Resendiz et al. 1998). Adult loggerheads also reside in oceanic waters off Japan (Hatase et al. 2002a). Habitat use off Japan may further be partitioned by sex and size (Hatase et al. 2002a; Hatase and Sakamoto 2004; Hatase et al. 2002b). Loggerheads returning to Japanese waters seem to migrate along nutrient-rich oceanic fronts (Kobayashi et al. 2008; Nichols et al. 2000; Polovina et al. 2000). Individuals bycaught and satellite tracked in Hawaii longline fisheries show individual movement north and south within a thermal range of 15-25º C, or 28-40º N, with juveniles following the 17-20º C isotherm (Kobayashi et al. 2008; Nichols et al. 2000; Polovina et al. 2004). The Transition Zone Chlorophyll Front and Kuroshio Extension Current are likely important foraging areas for juvenile loggerheads (Polovina et al. 2004). The Kuroshio Current off Japan may be significant for juvenile and adult loggerheads as a wintering areas for those individuals not migrating south (Hatase et al. 2002b).

Sighting and stranding records support loggerhead sea turtles to be common, year-round residents of the Gulf of Mexico, although their abundance is much greater in the northeastern region versus the northwestern (Davis et al. 2000b; Fritts et al. 1983; Landry and Costa 1999). An estimated 12% of all western North Atlantic Ocean loggerhead sea turtles reside in the eastern Gulf of Mexico, with the vast majority in western Florida waters (Davis et al. 2000a; TEWG 1998a) . Loggerheads may occur in both offshore habitats (particularly around oil platforms and reefs, where prey and shelter are available; (Davis et al. 2000b; Fritts et al. 1983; Gitschlag and Herczeg 1994; Lohoefener et al. 1990; Rosman et al. 1987), as well as shallow bays and sounds (which may be important developmental habitat for late juveniles in the eastern Gulf of Mexico; (Davis et al. 2000b; Lohoefener et al. 1990; USAF 1996). Offshore abundance in continental slope waters increases during the winter in the eastern Gulf of Mexico, as cooler inshore waters force individuals into warmer offshore areas (Davis et al. 2000b).

4.4.12.4 *Gender, Age, and Survivorship*

Although information on males is limited, several studies identified a female bias, although a single study has found a strong male bias to be possible (Dodd 1988a; NMFS 2001a; Rees and Margaritoulis 2004).

Additionally, little is known about longevity, although Dodd (1988a) estimated the maximum female life span at 47-62 years. Heppell et al. (2003a) estimated annual survivorship to be 0.81 (southeast U.S. adult females), 0.78-0.91 (Australia adult females), 0.68-0.89 (southeast U.S.

benthic juveniles, and 0.92 (Australia benthic juveniles). Another recent estimate suggested a survival rate of 0.41 or 0.60 (CIs 0.20-0.65 and 0.40-0.78, respectively), depending upon assumptions within the study (Sasso et al. 2011). Survival rates for hatchlings during their first year are likely very low (Heppell et al. 2003a; Heppell et al. 2003).

4.4.12.5 *Vocalization and Hearing*

Sea turtles are low-frequency hearing specialists, typically hearing frequencies from 30 to 2,000 Hz, with a range of maximum sensitivity between 100 and 800 Hz (Bartol et al. 1999b; Lenhardt 2002; Lenhardt 1994; Moein Bartol and Ketten 2006; Ridgway et al. 1969). Hearing below 80 Hz is less sensitive but still possible (Lenhardt 1994). Bartol et al. (1999b) reported effective hearing range for juvenile loggerhead turtles is from at least 250-750 Hz. Both yearling and two-year old loggerheads had the lowest hearing threshold at 500 Hz (yearling: about 81 dB re 1 μPa and two-year-olds: about 86 dB re 1 μPa), with thresholds increasing rapidly above and below that frequency (Moein Bartol and Ketten 2006).

These hearing sensitivities are similar to those reported for two terrestrial species: pond and wood turtles. Pond turtles respond best to sounds between 200 and 700 Hz, with slow declines below 100 Hz and rapid declines above 700 Hz, and almost no sensitivity above 3000 Hz (Wever and Vernon 1956). Wood turtles are sensitive up to about 500 Hz, followed by a rapid decline above 1000 Hz and almost no responses beyond 3000 or 4000 Hz (Patterson 1966).

4.4.12.6 *Status and Trends*

Loggerhead sea turtles were listed as threatened under the ESA of 1973 on July 28, 1978 (43 FR 32800). In 2009, a status review conducted for the loggerhead (the first turtle species subjected to a complete stock analysis) identified nine distinct population segments within the global population (Conant et al. 2009). In a September 2011 rulemaking, the NMFS and U.S. Fish and Wildlife Service listed five of these distinct population segments as endangered and kept four as threatened under the ESA, effective as of 24 October 2011 (FR 76 (184): 58868-58952, September 22, 2011). The North Pacific Ocean, South Pacific Ocean, North Indian Ocean, Northeast Atlantic Ocean, and Mediterranean Sea distinct population segments of the loggerhead sea turtle are classified as endangered under the ESA, and the Southeast Indo-Pacific Ocean, Southwest Indian Ocean, Northwest Atlantic Ocean, and South Atlantic Ocean distinct population segments are classified as threatened. The Northwest Atlantic Ocean distinct population segment is the only one that occurs entirely within the Study Area, with geographic boundaries between latitude 60° N and the equator, and stretching to longitude 40° W. However, loggerheads from other distinct population segments may occur within the Study Area. This population is likely to decline in the reasonably foreseeable future, primarily as a result of fishery bycatch (FR 69 (128): 40734-40758, July 6, 2004).

There is general agreement that the number of nesting females provides a useful index of the species' population size and stability at this life stage, even though there are doubts about the ability to estimate the overall population size (Bjorndal et al. 2005). An important caveat for population trends analysis based on nesting beach data is that this may reflect trends in adult nesting females, but it may not reflect overall population growth rates well. Adult nesting females often account for less than 1% of total population numbers. The global abundance of nesting female loggerhead turtles is estimated at 43,320–44,560 (Spotila 2004a).

Atlantic Ocean. In the eastern Atlantic, the Cape Verde Islands support the only known loggerhead nesting assemblage, which is of at least intermediate size (Fretey 2001c); 1,071 nests were observed in 2009 (Lino et al. 2010). In 2000, researchers tagged over 1,000 nesting females (Erhart et al. 2003). Annual data from monitoring projects in Cyprus, Greece, Israel, Tunisia, and Turkey reveal total annual nesting in the Mediterranean ranging of 3,375-7,085 nests per season (Margaritoulis et al. 2003). Libya and the West African coast host genetically-unique breeding populations of loggerhead sea turtles as well (Hutchinson and Dutton 2007). A recently discovered nesting site along the southern Italian shores of the Ionian Sea found particularly high genetic diversity amongst nesting females (Garofalo et al. 2009). Nesting at Dalyan Beach, Turkey does not have an apparent trend, with between 50 and 286 nests laid annually for the past 19 years (Turkozan and Yilmaz 2008).

The greatest concentration of loggerheads occurs in the Atlantic Ocean and the adjacent Caribbean Sea, primarily on the Atlantic coast of Florida, with other major nesting areas located on the Yucatán Peninsula of Mexico, Columbia, Cuba, South Africa (EuroTurtle 2006 as cited in LGL Ltd. 2007; Márquez 1990a).

Among the five subpopulations, loggerhead females lay 53,000-92,000 nests per year in the southeastern U.S. and the Gulf of Mexico, and the total number of nesting females is 32,000-56,000. All of these are currently in decline or data are insufficient to access trends (NMFS 2001a; TEWG 1998c). Loggerheads from western North Atlantic nesting aggregations may or may not feed in the same regions from which they hatch. Loggerhead sea turtles from the northern nesting aggregation, which represents about 9% of the loggerhead nests in the western North Atlantic, comprise 25-59% of individuals foraging from Georgia up to the northeast U.S. (Bass et al. 1998; Norrgard 1995; Rankin-Baransky 1997; Sears 1994; Sears et al. 1995). Loggerheads associated with the South Florida nesting aggregation occur in higher frequencies in the Gulf of Mexico (where they represent about 10% of the loggerhead captures) and the Mediterranean Sea (where they represent about 45% of loggerhead sea turtles captured). About 4,000 nests per year are laid along the Brazilian coast (Ehrhart et al. 2003).

The northern recovery unit along Georgia, South Carolina, and North Carolina has a forty-year time-series trend showing an overall decline in nesting, but the shorter comprehensive survey data (20 years) indicate a stable population (GDNR, NCWRC, and SCDNR nesting data located at www.seaturtle.org). NMFS scientists have estimated that the northern subpopulation produces 65% males (NMFS 2001a).

The peninsular Florida recovery unit is the largest loggerhead nesting assemblage in the northwest Atlantic. A near-complete nest census (all beaches including index nesting beaches) undertaken from 1989 to 2007 showed a mean of 64,513 loggerhead nests per year, representing approximately 15,735 nesting females annually (NMFS and USFWS 2008). The statewide estimated total for 2010 was 73,702 (FWRI nesting database). An analysis of index nesting beach data shows a 26% nesting decline between 1989 and 2008, and a mean annual rate of decline of 1.6% despite a large increase in nesting for 2008, to 38,643 nests (FWRI nesting database)(NMFS and USFWS 2008; Witherington et al. 2009). In 2009, nesting levels, while still higher than the lows of 2004, 2006, and 2007, dropped below 2008 levels to approximately 32,717 nests, but in 2010 a large increase was seen, with 47,880 nests on the index nesting beaches (FWRI nesting database). The 2010 index nesting number is the largest since 2000. With the addition of data through 2010, the nesting trend for the northwestern Atlantic DPS is slightly negative and not statistically different from zero (no trend)(NMFS and USFWS 2010). Preliminary, unofficial reports indicate that 2011 nesting may be a high nesting year on par with 2010.

Because of its size, the south Florida subpopulation of loggerheads may be critical to the survival of the species in the Atlantic, and in the past it was considered second in size only to the Oman nesting aggregation (NMFS 2006e; NMFS and USFWS 1991b). The South Florida population increased at ~5.3% per year from 1978-1990, and was initially increasing at 3.9-4.2% after 1990. An analysis of nesting data from 1989-2005, a period of more consistent and accurate surveys than in previous years, showed a detectable trend and, more recently (1998-2005), has shown evidence of a declining trend of approximately 22.3% (FFWCC 2007a; FFWCC 2007b; Witherington et al. 2009). This is likely due to a decline in the number of nesting females within the population (Witherington et al. 2009). Nesting data from the Archie Carr Refuge (one of the most important nesting locations in southeast Florida) over the last 6 years shows nests declined from approximately 17,629 in 1998 to 7,599 in 2004, also suggesting a decrease in population size[4]. Loggerhead nesting is thought to consist of just 60 nesting females in the Caribbean and Gulf of Mexico (NMFS 2006f). Based upon the small sizes of almost all nesting aggregations in the Atlantic, the large numbers of individuals killed in fisheries, and the decline of the only large nesting aggregation, we suspect that the extinction probabilities of loggerhead sea turtle populations in the Atlantic are only slightly lower than those of populations in the Pacific.

Zurita et al. (2003) found a statistically significant increase in the number of nests on seven of the beaches on Quintana Roo, Mexico, from 1987-2001, where survey effort was consistent during the period. However, nesting has declined since 2001, and the previously reported increasing trend appears to have been temporary (NMFS and USFWS 2008).

4.4.12.7 *Natural Threats*

Sea turtles face predation primarily by sharks and to a lesser extent by killer whales. All sea turtles except leatherbacks can undergo "cold stunning" if water temperatures drop below a threshold level, which can pose lethal effects. In January 2010, an unusually large cold-stunning

[4] While this is a long period of decline relative to the past observed nesting pattern at this location, aberrant ocean surface temperatures complicate the analysis and interpretation of these data. Although caution is warranted in interpreting the decreasing nesting trend given inherent annual fluctuations in nesting and the short time period over which the decline has been noted, the recent nesting decline at this nesting beach is reason for concern.

event occurred throughout the southeast U.S., with well over 3,000 sea turtles (mostly greens but also hundreds of loggerheads) found cold-stunned. Most survived, but several hundred were found dead or died after being discovered in a cold-stunned state. Eggs are commonly eaten by raccoons and ghost crabs along the eastern U.S. (Barton and Roth 2008). In the water, hatchlings are hunted by herons, gulls, dogfish, and sharks. Heavy loads of barnacles are associated with unhealthy or dead stranded loggerheads (Deem et al. 2009).

4.4.12.8 *Anthropogenic Threats*

Anthropogenic threats impacting loggerhead nesting habitat are numerous: coastal development and construction, placement of erosion control structures, beachfront lighting, vehicular and pedestrian traffic, sand extraction, beach erosion, beach nourishment, beach pollution, removal of native vegetation, and planting of non-native vegetation (Baldwin 1992; Margaritoulis et al. 2003; Mazaris et al. 2009b; USFWS 1998). Surprisingly, beach nourishment also hampers nesting success, but only in the first year post-nourishment before hatching success increases (Brock et al. 2009). Loggerhead sea turtles face numerous threats in the marine environment as well, including oil and gas exploration, marine pollution, trawl, purse seine, hook and line, gill net, pound net, longline, and trap fisheries, underwater explosions, dredging, offshore artificial lighting, power plant entrapment, entanglement in debris, ingestion of marine debris, marina and dock construction and operation, boat collisions, and poaching. At least in the Mediterannean Sea, Anthorpogenic threats appear to disproportionally impact larger (more fecund) loggerheads (Bellido et al. 2010).

The major factors inhibiting their recovery include mortalities caused by fishery interactions and degradation of the beaches on which they nest. Shrimp trawl fisheries account for the highest number of captured and killed loggerhead sea turtles. Pacific bycatch is much less, with about 400 individuals bycaught annually in U.S. fisheries resulting in at least 20 mortalities (Finkbeiner et al. 2011). As a result of the 2006 and 2007 tri-national fishermen's exchanges in 2007 a prominent Baja California Sur fleet retired its bottom-set longlines (Peckham et al. 2008). Prior to this closure, the longline fleet interacted with an estimated 1,160-2,174 loggerheads annually, with nearly all (89%) of the takes resulting in mortalities(Peckham et al. 2008). Offshore longline tuna and swordfish longline fisheries are also a serious concern for the survival and recovery of loggerhead sea turtles and appear to affect the largest individuals more than younger age classes (Aguilar et al. 1995; Bolten et al. 1994; Carruthers et al. 2009; Howell et al. 2008; Marshall et al. 2009; Petersen et al. 2009; Tomás et al. 2008). In the Pacific Ocean, between 2,600 and 6,000 loggerhead sea turtles are estimated to have been captured and killed in longline fisheries in 2000 (Lewison et al. 2004). Shallow-set Hawaii based longline fisheries are estimated to have captured and killed several hundred loggerhead sea turtles before they were closed in 2001. When they were re-opened in 2004, with substantial modifications to protect sea turtles, these fisheries were estimated to have captured and killed about fewer than 5 loggerhead sea turtles each year. Between 2004 and 2008, shallow-set fisheries based out of Hawaii are estimated to have captured about 45 loggerhead sea turtles, killing about 10 of these sea turtles. Deliberate hunting of loggerheads for their meat, shells, and eggs has declined from previous exploitation levels, but still exists and hampers recovery efforts (Lino et al. 2010). In the Pacific, loggerhead turtles are captured, injured, or killed in numerous Pacific fisheries including Japanese longline fisheries in the western Pacific Ocean and South China Seas direct harvest and commercial fisheries off Baja California, Mexico commercial and artisanal swordfish fisheries off Chile, Columbia, Ecuador, and Peru purse seine fisheries for tuna in the eastern tropical Pacific Ocean California/Oregon drift gillnet fisheries (NMFS 2006e) Wallace et al. (2010) estimated that between 1990 and 2008, at least 85,000 sea turtles were captured as bycatch in fisheries worldwide. This estimate is likely at least two orders of magnitude low, resulting in a likely bycatch of nearly half a million sea turtles annually (Wallace et al. 2010); many of these are expected to be loggerhead sea turtles.

Marine debris ingestion can be a widespread issue for loggerhead sea turtles. More than one-third of loggerheads found stranded or bycaught had injected marine debris in a Mediterranean study, with possible mortality resulting in some cases (Lazar and Gračan 2010).

Climate change may also have significant implications on loggerhead populations worldwide. In addition to potential loss of nesting habitat due to sea level rise, loggerhead sea turtles are very sensitive to temperature as a determinant of sex while incubating. Ambient temperature increase by just 1º-2º C can potentially change hatchling sex ratios to all or nearly all female in tropical and subtropical areas (Hawkes et al. 2007a). Over time, this can reduce genetic diversity, or even population viability, if males become a small proportion of populations (Hulin et al. 2009). Sea surface temperatures on loggerhead foraging grounds correlate to the timing of nesting, with higher temperatures leading to earlier nesting (Mazaris et al. 2009a; Schofield et al. 2009). Increasing ocean temperatures may also lead to reduced primary productivity and eventual food availability. This has been proposed as partial support for reduced nesting abundance for loggerhead sea turtles in Japan; a finding that could have broader implications for other populations in the future if individuals do not shift feeding habitat (Chaloupka et al. 2008c). Warmer temperatures may also decrease the energy needs of a developing embryo (Reid et al. 2009).

Tissues taken from loggerheads sometimes contain very high levels of organochlorines chlorobiphenyl, chlordanes, lindane, endrin, endosulfan, dieldrin, PFOS, PFOA, DDT, and PCB (Alava et al. 2006; Corsolini et al. 2000; Gardner et al. 2003; Keller et al. 2005; Keller et al. 2004a; Keller et al. 2004b; McKenzie et al. 1999; Monagas et al. 2008; Oros et al. 2009; Perugini et al. 2006; Rybitski et al. 1995; Storelli et al. 2007a). It appears that levels of organochlorines have the potential to suppress the immune system of loggerhead sea turtles and may affect metabolic regulation (Keller et al. 2004c; Keller et al. 2006b; Oros et al. 2009). These contaminants could cause deficiencies in endocrine, developmental, and reproductive health (Storelli et al. 2007a). It is likely that the omnivorous nature of loggerheads makes them more prone to bioaccumulating toxins than other sea turtle species (Godley et al. 1999; McKenzie et al. 1999).

Heavy metals, including arsenic, barium, cadmium, chromium, iron, lead, nickel, selenium, silver, copper, zinc, and manganese, have also been found in a variety of tissues in levels that increase with turtle size (Anan et al. 2001; Fujihara et al. 2003; Garcia-Fernandez et al. 2009; Gardner et al. 2006; Godley et al. 1999; Saeki et al. 2000; Storelli et al. 2008). These metals likely originate from plants and seem to have high transfer coefficients (Anan et al. 2001; Celik et al. 2006; Talavera-Saenz et al. 2007).

Loggerhead sea turtles have higher mercury levels than any other sea turtle studied, but concentrations are an order of magnitude less than many toothed whales (Godley et al. 1999; Pugh and Becker 2001b). Arsenic occurs at levels several fold more concentrated in loggerhead sea turtles than marine mammals or seabirds.

Also of concern is the spread of antimicrobial agents from human society into the marine environment. Loggerhead sea turtles may harbor antibiotic-resistant bacteria, which may have developed and thrived as a result of high use and discharge of antimicrobial agents into freshwater and marine ecosystems (Foti et al. 2009).

4.4.12.9 ***Critical Habitat***

In 2009, a status review conducted for the loggerhead (the first turtle species subjected to a complete stock analysis) identified nine distinct population segments within the global population (Conant et al. 2009). In a September 2011 rulemaking, the NMFS and U.S. Fish and Wildlife Service listed five of these distinct population segments as endangered and kept four as threatened under the ESA, effective as of 24 October 2011 (FR 76 (184): 58868-58952, September 22, 2011). The North Pacific Ocean, South Pacific Ocean, North Indian Ocean, Northeast Atlantic Ocean, and Mediterranean Sea distinct population segments of the loggerhead sea turtle are classified as endangered under the ESA, and the Southeast Indo-Pacific Ocean, Southwest Indian Ocean, Northwest Atlantic Ocean, and South Atlantic Ocean distinct population segments are classified as threatened. The Northwest Atlantic Ocean distinct population segment is the only one that occurs entirely within the Study Area, with geographic boundaries between latitude 60° N and the equator, and stretching to longitude 40° W. However, loggerheads from other distinct population segments may occur within the Study Area. This population is likely to decline in the reasonably foreseeable future, primarily as a result of fishery bycatch (FR 69 (128): 40734-40758, July 6, 2004).

At the time of listing loggerhead sea turtle distinct population segments, the U.S. Fish and Wildlife Service and NMFS determined that they lacked the comprehensive data and information necessary to identify and propose critical habitat, and stated that critical habitat would be proposed in a separate rulemaking (FR 76 (184): 58868-58952, September 22, 2011). On 25 March 2013, the U.S. Fish and Wildlife Service proposed to designate 739.3 mi. (1,189.9 km) of loggerhead sea turtle nesting beaches as critical habitat for the Northwest Atlantic Ocean Distinct Population Segment in coastal counties in North Carolina, South Carolina, Georgia, Florida, Alabama, and Mississippi. This accounts for 48 percent of an estimated 1,531 mi. (2,464 km) of coastal beach shoreline, and approximately 84 percent of the documented numbers of nests within these six states (FR 78 (57): 1800-18082, March 25, 2013).

None of this proposed critical habitat includes DoD areas of Marine Corps Base Camp Lejeune (Onslow Beach), Cape Canaveral Air Force Station, Patrick Air Force Base, and Eglin Air Force Base, which are exempt from critical habitat designation because their Integrated Natural Resources Management Plans incorporate measures that provide a benefit for the conservation of the loggerhead sea turtle.

On 18 July 2013, NMFS proposed critical habitat (See figure below) for the Northwest Atlantic Ocean loggerhead sea turtle Distinct Population Segment (DPS) (*Caretta caretta*) within the Atlantic Ocean and the Gulf of Mexico. Specific areas proposed for designation include 36 occupied marine areas within the range of the Northwest Atlantic Ocean DPS. These areas contain one or a combination of nearshore reproductive habitat, winter area, breeding areas, and migratory corridors.

At the time of this consultation, NMFS was determining whether to include as critical habitat in the final rule some areas that contain foraging habitat and two large areas that contain *Sargassum* habitat (See figure below). The designation of Sargassum critical habitat would help conserve loggerhead sea turtles by (1) providing for essential forage, cover, and transport habitat for a particularly vulnerable life stage (e.g., post-hatchlings); and (2) ensuring habitat longevity for a habitat type that is important to multiple life stages and not able to be easily replicated. No marine areas meeting the definition of critical habitat were identified within the jurisdiction of the United States for the North Pacific Ocean DPS, and therefore NMFS did not propose to designate critical habitat for that DPS.

The U.S. Navy coordinated with NMFS during the development of the proposed CH rule to ensure there would be no impacts to national security as a result of the proposed designation. As a result of this coordination, NMFS determined that Navy activities, such as those described in this proposed action, would have no impacts on the physical and biological features of the proposed critical habitat (see Federal Register Vol. 78, page 43030).

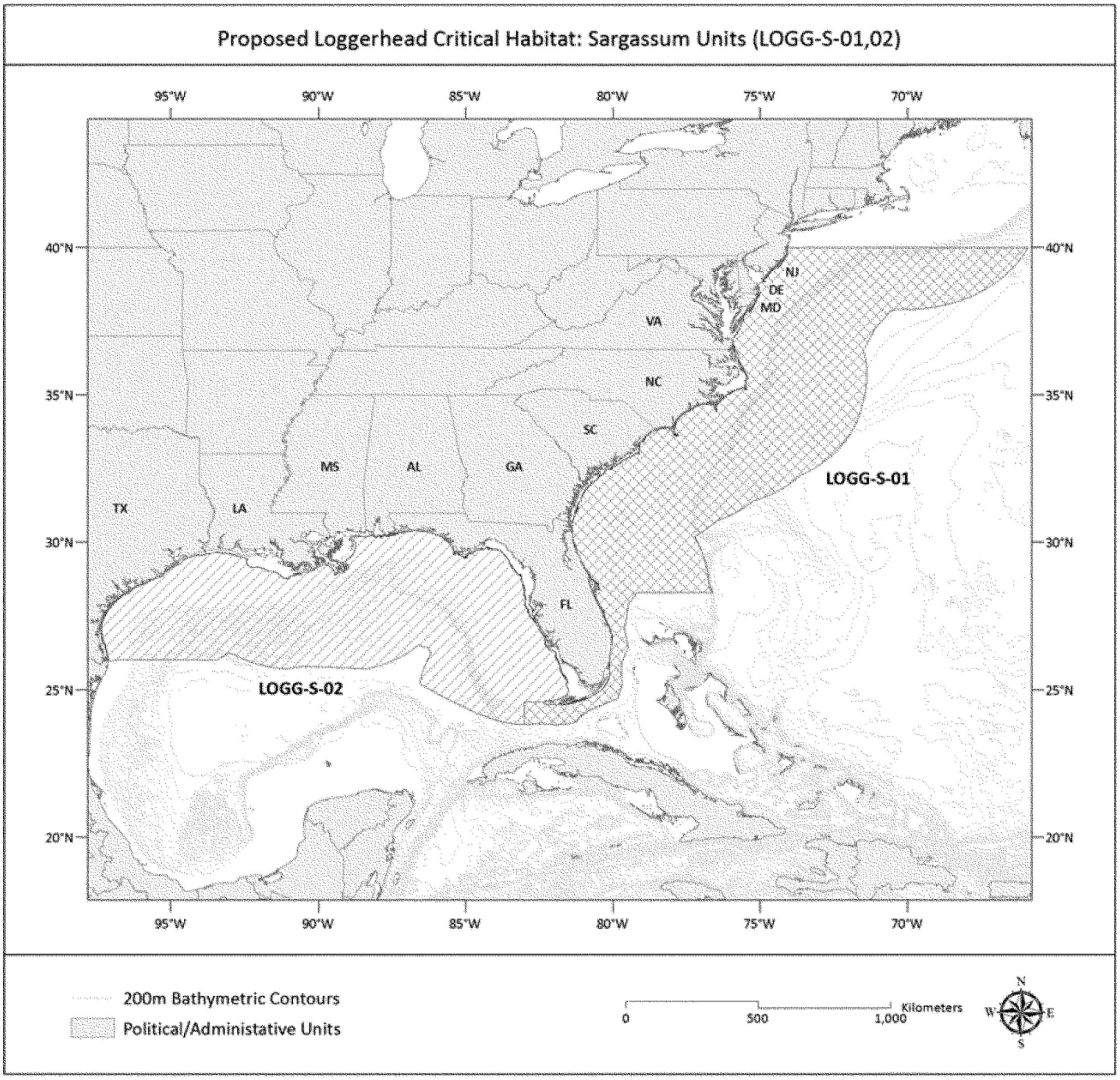

Figure 14. Proposed Critical Habitat for Loggerhead – Sargassum Units

Below is a summary of primary constituent elements identified for the proposed critical habitat by habitat type:

PCEs that support nearshore reproductive habitat are the following:

(1) Nearshore waters directly off the highest density nesting beaches as identified in 78 FR 18000 (March 25, 2013) to 1.6 km offshore;

(2) Waters sufficiently free of obstructions or artificial lighting to allow transit through the surf zone and outward toward open water; and

(3) Waters with minimal manmade structures that could promote predators (i.e., nearshore predator concentration caused by submerged and emergent offshore structures), disrupt wave patterns necessary for orientation, and/or create excessive longshore currents.

The PCEs that support Foraging Habitat are:

(1) Sufficient prey availability and quality, such as benthic invertebrates, including crabs (spider, rock, lady, hermit, blue, horseshoe), mollusks, echinoderms and sea pens; and

(2) Water temperatures to support loggerhead inhabitance, generally above 10° C.

NMFS describes the physical and biological features (PBF) of winter habitat as warm water habitat south of Cape Hatteras, North Carolina near the western edge of the Gulf Stream used by a high concentration of juveniles and adults during the winter months.

PCEs that support winter habitat are the following:

(1) Water temperatures above 10 °C from November through April;

(2) Continental shelf waters in proximity to the western boundary of the Gulf Stream; and

(3) Water depths between 20 and 100 m.

NFMS describes the PBFs of concentrated breeding habitat as sites with high concentrations of both male and female adult individuals during the breeding season.

PCEs that support this habitat are the following:

(1) High concentrations of reproductive male and female loggerheads;

(2) Proximity to primary Florida migratory corridor; and

(3) Proximity to Florida nesting grounds.

NMFS describes the PBF of constricted migratory habitat as high use migratory corridors that are constricted (limited in width) by land on one side and the edge of the continental shelf and Gulf Stream on the other side.

PCEs that support this habitat are the following:

(1) Constricted continental shelf area relative to nearby continental shelf waters that concentrate migratory pathways; and

(2) Passage conditions to allow for migration to and from nesting, breeding, and/or foraging areas.

NMFS describes the PBF of loggerhead *Sargassum* habitat as developmental and foraging habitat for young loggerheads where surface waters form accumulations of floating material, especially *Sargassum.*

PCEs that support this habitat are the following:

(1) Convergence zones, surface-water downwelling areas, and other locations where there are concentrated components of the*Sargassum* community in water temperatures suitable for the optimal growth of *Sargassum* and inhabitance of loggerheads;

(2) *Sargassum* in concentrations that support adequate prey abundance and cover;

(3) Available prey and other material associated with *Sargassum*habitat including, but not limited to, plants and cyanobacteria and animals endemic to the *Sargassum* community such as hydroids and copepods; and

(4) Sufficient water depth and proximity to available currents to ensure offshore transport, and foraging and cover requirements by *Sargassum* for post-hatchling loggerheads, i.e., >10 m depth to ensure not in surf zone.

More information on proposed critical habitat for loggerhead sea turtles can be found at: https://www.federalregister.gov/articles/2013/07/18/2013-17204/endangered-and-threatened-species-designation-of-critical-habitat-for-the-northwest-atlantic-ocean#h-8

4.4.13 **Smalltooth Sawfish**

The smalltooth sawfish is a tropical marine and estuarine elasmobranch fish (sharks and rays) that has been reported to have a circumtropical distribution. Although they are rays, sawfish physically more resemble sharks, with only the trunk and especially the head ventrally flattened. Smalltooth sawfish are characterized by their "saw," a long, narrow, flattened rostral blade with a series of transverse teeth along either edge.

4.4.13.1 ***Distribution***

In the western Atlantic, the smalltooth sawfish has been reported from Brazil through the Caribbean and Central America, the Gulf of Mexico, and the Atlantic coast of the U.S. The smalltooth sawfish has also been recorded from Bermuda (Bigelow and Schroeder 1953a). Forms of smalltooth sawfish have been reported from the eastern Atlantic in Europe and West Africa; the Mediterranean; South Africa; and the Indo-West Pacific, including the Red Sea, India, Burma, and the Philippines (Bigelow and Schroeder 1953a; Compagno and Cook 1995; Van der Elst 1981). Whether populations outside of the Atlantic are truly smalltooth sawfish or closely related species is unknown (Adams and Wilson 1995). Pacific coast records of smalltooth sawfish off Central America need confirmation (Bigelow and Schroeder 1953a;

Compagno and Cook 1995).

The range of the smalltooth sawfish in the Atlantic has contracted markedly over the past century. The northwestern terminus of their Atlantic range is located in the waters of the eastern U.S. Historic capture records within the U.S. range from Texas to New York. Water temperatures no lower than 61°F to 64.4°F and the availability of appropriate coastal habitat serve as the major environmental constraints limiting the northern movements of smalltooth sawfish in the western North Atlantic (Simpfendorfer 2001). As a result, most records of this species from areas north of Florida occur during spring and summer periods (May to August) when inshore waters reach appropriately high temperatures. The data also suggest that smalltooth sawfish may utilize warm water outflows of power stations as thermal refuges during colder months to enhance their survival or become trapped by surrounding cold water from which they would normally migrate. Almost all occurrences of smalltooth sawfish in warm-water outflows were during the coldest part of the year, when water temperatures in these outfalls are typically well above ambient temperatures.

4.4.13.2 *Movement*

Historic records of smalltooth sawfish indicate that some large mature individuals migrated north along the U.S. Atlantic coast as temperatures warmed in the summer and then south as temperatures cooled (Bigelow and Schroeder 1953a). Recent Florida encounter data, however, do not suggest such migration. Only two smalltooth sawfish have been recorded north of Florida since 1963 (the first was captured off of North Carolina in 1999 and the other off Georgia 2002) but it is unknown whether these individuals resided in Georgia and North Carolina waters annually or if they had migrated north from Florida (Schwartz 2003b, Burgess unpublished data). Given the very limited number of encounter reports from the east coast of Florida, Simpfendorfer and Wiley (2004) hypothesize the population previously undertaking the summer migration has declined to a point where the migration is undetectable or does not occur.

Most specimens captured along the Atlantic coast north of Florida have also been large (>9 feet) adults and likely represent seasonal migrators, wanderers, or colonizers from a core population(s) to the south rather than being members of a continuous, even-density population (Bigelow and Schroeder 1953a). It is likely that these individuals migrated southward toward Florida as water temperatures declined in the fall, as there is only one winter record from the Atlantic coast north of Florida. Based on smalltooth sawfish encounter data, the current core range for the smalltooth sawfish is from the Caloosahatchee River, Florida, to Florida Bay (NMFS 2000; Simpfendorfer and Wiley 2004).[5]

[5] See the 2006 Draft Recovery Plan for more detailed information on the historic and current distribution of smalltooth sawfish in four regions of the eastern U.S. This information is based on the Status Review Team's analysis and the more recent encounter database research.

4.4.13.3 *Habitat*

Smalltooth sawfish are euryhaline, occurring in waters with a broad range of salinities from freshwater to full seawater (Simpfendorfer 2001). Younger, smaller individuals tend to inhabit very shallow mud banks and tides are a major factor in their movement (Simpfendorfer et al. 2010). As they grow, juveniles tend to occupy deeper habitat, but shallow areas (<1 m depth) remain preferred habitat; juveniles also expand their ranges, whereas small individuals have very restricted ranges (Simpfendorfer et al. 2010). Their occurrence in freshwater is suspected to be only in estuarine areas temporarily freshwater from receiving high levels of freshwater input. Many encounters are reported at the mouths of rivers or other sources of freshwater inflows, suggesting estuarine areas may be an important factor in the species distribution (Simpfendorfer and Wiley 2004).

Smalltooth sawfish are most common in shallow coastal waters less than 82 feet (Adams and Wilson 1995; Bigelow and Schroeder 1953a). Indeed, the distribution of the smallest size classes of smalltooth sawfish indicate that nursery areas occur throughout Florida in areas of shallow water, close to shore and typically associated with mangroves (Simpfendorfer and Wiley 2004). However, encounter data indicate there is a tendency for smalltooth sawfish to move offshore and into deeper water as they grow. Larger animals are more likely to be found in deeper waters. Since large animals are also observed in very shallow waters, it is believed that smaller (younger) animals are restricted to shallow waters, while large animals roam over a much larger depth range (Simpfendorfer 2001). Recent data from sawfish encounter reports and from satellite tagging indicate mature animals occur regularly in waters in excess of 164 feet (Poulakis and Seitz 2004c; Simpfendorfer and Wiley 2004).

4.4.13.4 *Growth and Reproduction*

As in all elasmobranchs, fertilization is internal. Bigelow and Schroeder (1953a) report the litter size as 15 to 20. Simpfendorfer and Wiley (2004), however, caution this may be an overestimate, with recent anecdotal information suggesting smaller litter sizes (about ten). Smalltooth sawfish mating and pupping seasons, gestation, and reproductive periodicity are all unknown. Gestation and reproductive periodicity, however, may be inferred based on that of the largetooth sawfish, sharing the same genus and having similarities in size and habitat. Thorson (1976a) reported the gestation period for largetooth sawfish was approximately five months and concluded that females probably produce litters every second year.

Bigelow and Schroeder (1953a) describe smalltooth sawfish as generally about 2 feet long at birth and growing to a length of 18 feet or greater. Recent data from smalltooth sawfish caught off Florida, however, demonstrate young are born at 2.5 to 2.8 feet (Simpfendorfer and Wiley 2004), with males reaching maturity at approximately 8.9 feet and females at approximately 11.8 feet (Simpfendorfer 2002). The maximum reported size of a smalltooth sawfish is 24.9 feet (Last and Stevens 1994), but the maximum size normally observed is 19.7 feet (Adams and Wilson 1995). No formal studies on the age and growth of the smalltooth sawfish have been conducted to date, but growth studies of largetooth sawfish suggest slow growth, late maturity (10 years) and long lifespan (25 to 30 years Simpfendorfer 2000b; Thorson 1982). These characteristics suggest a very low intrinsic rate of increase (Simpfendorfer 2000b).

4.4.13.5 *Feeding*

Smalltooth sawfish feed primarily on fish, with mullet, jacks, and ladyfish believed to be their primary food resources (Simpfendorfer 2001). In addition to fish, smalltooth sawfish also prey on crustaceans (mostly shrimp and crabs), which are located by disturbing bottom sediment with their saw (Bigelow and Schroeder 1953a; Norman and Fraser 1937).

4.4.13.6 *Status and Trends*

The U.S. smalltooth sawfish distinct population segment (DPS) was listed as endangered under the ESA on 1 April 2003 (68 FR 15674). The smalltooth sawfish is the first marine fish to be listed in the U.S. Despite being widely recognized as common throughout their historic range up until the middle of the 20th century, the smalltooth sawfish population declined dramatically during the middle and later parts of the century. The decline in the population of smalltooth sawfish is attributed to fishing (both commercial and recreational), habitat modification, and sawfish life history. Large numbers of smalltooth sawfish were caught as bycatch in the early part of this century. Smalltooth sawfish were historically caught as bycatch in various fishing gears throughout their historic range, including gillnet, otter trawl, trammel net, seine, and to a lesser degree, handline. Frequent accounts in earlier literature document smalltooth sawfish being entangled in fishing nets from areas where smalltooth sawfish were once common but are now rare (Evermann and Bean 1898). Loss and/or degradation of habitat contributed to the decline of many marine species and continue to impact the distribution and abundance of smalltooth sawfish. Simpfendorfer (2001) estimated that the U.S. population size is currently less than 5% of its size at the time of European settlement.

Seitz and Poulakis (2002) and Poulakis and Seitz (2004c) documented recent (1990 to 2002) occurrences of sawfish along the southwest coast of Florida, and in Florida Bay and the Florida Keys, respectively and includes a total of 2,969 smalltooth sawfish encounters. Mote Marine Laboratory also maintains a smalltooth sawfish public encounter database, established in 2000 to compile information on the distribution and abundance of sawfish. A total of 434 sawfish encounters have been validated since 1998, most from recreational fishers (Simpfendorfer and Wiley 2004). Dr. Simpfendorfer reluctantly gives an estimate of 2,000 individuals based on his four years of field experience and data collected from the public, but cautions that actual numbers may be plus or minus at least 50%.

The majority of smalltooth sawfish encounters today are from the southwest coast of Florida between the Caloosahatchee River and Florida Bay. Outside of this core area, the smalltooth sawfish appears more common on the west coast of Florida and in the Florida Keys than on the east coast, and occurrences decrease the greater the distance from the core area (Simpfendorfer and Wiley 2004). The capture of a smalltooth sawfish off Georgia in 2002 is the first record north of Florida since 1963. New reports during 2004 extend the current range of the species to Panama City, offshore Louisiana (south of Timbalier Island in 100 feet of water), southern Texas (unconfirmed), and the northern coast of Cuba.

The abundance of juveniles encountered, including very small individuals, suggests that the population remains reproductively active and viable (Seitz and Poulakis 2002; Simpfendorfer 2003; Simpfendorfer and Wiley 2004). The declining numbers of individuals with increasing size is consistent with the historic size composition data (G. Burgess, pers. comm. in

Simpfendorfer and Wiley 2004). This information and recent encounters in new areas beyond the core abundance area suggest that the population may be increasing. However, recovery of the species is expected to be slow on the basis of the species' life history and other threats to the species remaining (see below), the population's future remains tenuous.

4.4.13.7 *Natural Threats*

The primary natural threat to smalltooth sawfish survival is the species low reproductive rate. In the face of reduced population sizes, this biological parameter means that recovery, at best, will be slow, and that catastrophic perturbations can have severer consequences to recovery.

4.4.13.8 *Anthropogenic Threats*

Smalltooth sawfish decline has been largely due to fisheries interaction (see NMFS 2006f for a review). The distinctive "saw" can easily become entangled in a variety of commercial and recreational fishing gear, resulting in drowning or injury. Even when individuals that have been entangled are retrieved alive, individuals may be killed for curio collection of the saw, fear of injury from fisherman, or injured from the gear or handling during gear removal. However, additional anthropogenic impacts result from habitat loss. Destruction of mangrove habitat, dredging, trawling and filling, and loss of reef habitat have negative impacts on all life stages of smalltooth sawfish. Although a concern, pollution impacts on particularly reproductive biology are unknown. However, habitat degradation due to runoff containing pesticides, eutrophying agents, and other contaminants can also have a negative impact on smalltooth sawfish habitat.

4.4.13.9 *Critical Habitat*

On 2 September 2009, critical habitat was designated for smalltooth along the central and southwest coast of Florida (74 FR 45353). The two locations include Charlotte Harbor Estuary and the Ten Thousand Islands portion of the Everglades. Most of this designated critical habitat lies in the boundaries of the federally managed Everglades National Park, Rookery Bay Aquatic Preserve, and Cape Romano-Ten Thousand Islands Aquatic Preserve. The Key West Range Complex does not overlap these critical habitat areas; the northeastern boundary (W-174) of the Key West Range Complex is within approximately nine nautical miles (nm) of critical habitat at its closest point.

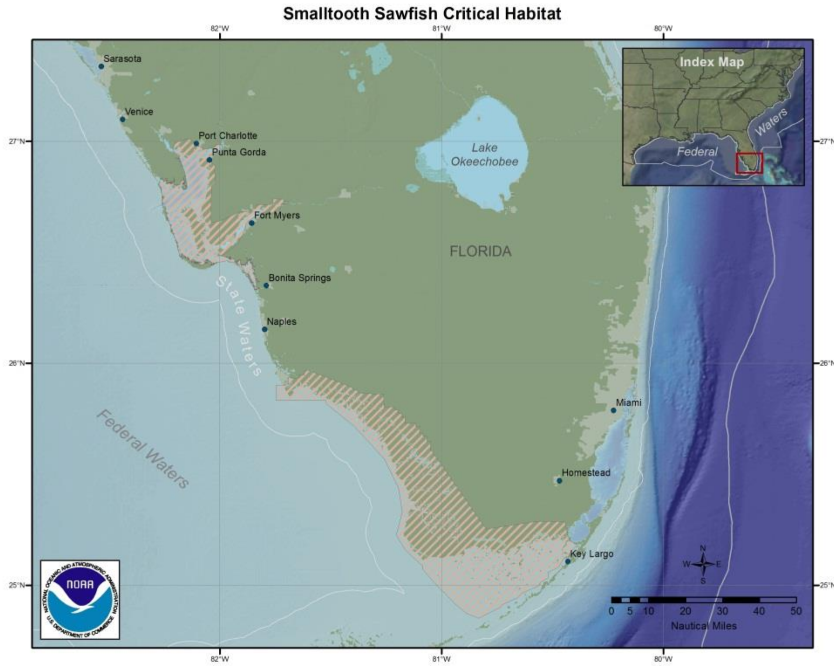

Figure 15. Smalltooth Sawfish Critical Habitat

Although PCEs were not identified, the mangrove and adjacent shallow euryhaline habitat are important nursery habitat for smalltooth sawfish. These habitats are characterized by variable salinities with water depths between the mean high water line and 3 ft. (0.9 m) measured at mean lower low water.

4.4.14 Atlantic Sturgeon

Atlantic sturgeon were once present in 38 river systems and, of these, spawned in 35 of them. Individuals are currently present in 36 rivers, and spawning occurs in at least 20 of these. Modern genetic analyses suggest that Atlantic sturgeon exhibit high fidelity to their natal rivers (Harwood 2010). Because of high natal river fidelity, it appears that most rivers support independent populations (Grunwald et al. 2008; King et al. 2001; Waldman and Wirgin 1998; Wirgin et al. 2002; Wirgin et al. 2000).

4.4.14.1 *Distribution*

Atlantic sturgeon once ranged from Hamilton Inlet on the coast of Labrador to the Saint Johns River in Florida and extralimitally to Bermuda and Venezuela (ASSRT 2007; Read 2010; Smith and Clugston 1997).

4.4.14.2 *Reproduction and Growth*

The general life history pattern of Atlantic sturgeon is that of a long lived, late maturing, iteroparous, anadromous species.

Spawning intervals range from once every one to five years for males (Bain 1997; Collins et al. 2000a; Schueller and Peterson 2010; Smith 1985) and three to five years for females (Bain 1997;

Gales et al. 2010; Schueller and Peterson 2010; Stevenson and Secor 1999). Fecundity increases with age and body size (ranging from 400,000 – 8 million eggs) (Dadswell 2006; Hammond 2010; Van Eenennaam and Doroshov 1998). The average age at which 50% of maximum lifetime egg production is achieved is estimated to be 29 years, approximately 3-10 times longer than for other bony fish species examined (Boreman 1997).

Sturgeon eggs are highly adhesive and are deposited on the bottom substrate, usually on hard surfaces (e.g., cobble) (Gilbert 1989; Smith and Clugston 1997). Hatching occurs approximately 94-140 hrs after egg deposition, and larvae assume a bottom-dwelling existence (Anonmyous 2010a). The yolksac larval stage is completed in about 8-12 days, during which time larvae move downstream to rearing grounds over a 6 – 12 day period (Kynard and Horgan 2002). During the daytime, larvae use benthic structure (e.g., gravel matrix) as refugia (Kynard and Horgan 2002). Juvenile sturgeon continue to move further downstream into brackish waters, and eventually become residents in estuarine waters for months or years.

Atlantic sturgeon may reach ages of 60 years or more, but aging studies are limited by inaccuracy once individuals are older than 15 years old (Jackson et al. 2007; Nakamoto et al. 1995; Rien and Beamesderfer 1994; Rossiter et al. 1995; Stevenson and Secor 1999; Van Eenennaam et al. 1996; Whiteman et al. 2004). Individuals grow rapidly once they migrate out of natal streams, but experience slower growth once they reach sexual maturity and beyond (Dovel and Berggren 1983; Harrison and Thurley 1974). Individuals in southern waters may have shorter life spans.

4.4.14.3 *Habitat*

Estuaries along the coast that do not support Atlantic sturgeon spawning populations may still be important rearing habitats. The removal or retrofitting of dams to allow fish passage is anticipated to allow sturgeon to return to much of their former habitat in the Penobscot River (Trinko Lake et al. 2012). The Carolina coast apprears to be an overwintering area (Breece et al. 2011) and high concentrations of sturgeon occur off Rockaway, New York (Dunton et al. 2011).

4.4.14.4 *Movement*

Atlantic sturgeon spawn in freshwater, but spend most of their sub-adult and adult life in the marine environment. While few specific spawning locations have been identified in the United States, through genetic analysis, many rivers are known to support reproducing populations. Early life stage Atlantic sturgeon coupled with upstream movements of adults suggest spawning adults generally migrate upriver in the spring and early summer; this includes February-March in southern systems, April-May in mid-Atlantic systems, and May-July in Canadian systems (Bain 1997; Kahnle et al. 1998b; Smith 1985; Smith and Clugston 1997). Some rivers may also support a fall spawning migration.

Sub-adult and adult Atlantic sturgeon undertake long marine migrations and utilize East Coast nearshore marine for rearing, feeding, and migrating (Bain 1997; Dovel and Berggren 1983; Harrison and Thurley 1974). Migratory sub-adults and adults normally occur in shallow (10-50m) waters dominated by gravel and sand substrate (Stein et al. 2004). Tagging and genetic data indicate that sub-adult and adult Atlantic sturgeon may travel widely after emigrating from rivers. Despite extensive mixing in coastal waters, Atlantic sturgeon display high site fidelity to their natal streams. Straying between rivers within a proposed DPS would sometimes exceed five migrants per generation, but between DPS exchanges are usually less than one migrant per generation, with the exception of fish from the Delaware River straying more frequently to southern rivers (Grunwald et al. 2008).

4.4.14.5 ***Diet***

Atlantic sturgeon feed primarily on polychaetes, isopods, and amphipods in the marine environment, while in fresh water, they feed on oligochaetes, gammarids, mollusks, insects, and chironomids (Brosse et al. 2002; Collins et al. 2008; Guilbard et al. 2007; Haley 1998; Haley 1999; Johnson et al. 1997; Moser and Ross 1995; Savoy 2007). There is some disagreement as to whether Atlantic sturgeon cease foraging during certain times or in certain places. Although there is some evidence to support a portion of individuals not foraging in spring or in freshwater, evidence also exists to support half to almost all individuals foraging in these circumstances (Brosse et al. 2002; Collins et al. 2008).

Several authors have found that polychaetes constitute a major portion of Atlantic sturgeon diets. Brosse et al. (2002) reported that over 90% of Atlantic sturgeon diet was polychaetes during spring, summer, and winter. Savoy (2007) found Atlantic sturgeon diets consisted of approximately 66% polychaetes and 27% decapods in Long Island Sound while at the mouth of the Connecticut River, individuals fed almost exclusively on polychaetes. At the mouth of the Hudson River, Haley (1999) found that sturgeon fed on 47% polychaetes, 27% amphipods, and 22% isopods. In North Carolina, Moser and Ross (1995) determined Atlantic sturgeon diets were different, feeding on 32% polychaetes, 28% isopods, 12% mollusks, and then other items. In South Carolina, Collins et al. (2008) identified the proportion of the sampled Atlantic sturgeon with each species in their guts and most guts contained polychaetes (over 50% of the fish that had been feeding had polychaetes in their guts).

4.4.14.6 ***Status and Trends***

On 6 October 2010, NMFS published a proposed rule (75 FR 61904) to list the Carolina and South Atlantic DPSs, the two DPSs that spawn in the NMFS Southeast Region, as endangered. A separate proposed rule (75 FR 91872) was published on 6 October 2010, for the three DPSs of Atlantic sturgeon that spawn in the NMFS Northeast Region. On 6 June 2011, NMFS proposed protective measures for the Gulf of Maine DPS (76 FR 34023).

Prior to 1890, Atlantic sturgeon populations were at or near carrying capacity. In the mid-1800s, incidental catches of Atlantic sturgeon in the shad and river herring haul seine fisheries indicated that the species was very abundant (Armstrong and Hightower 2002). A major, targeted fishery did not exist until 1870 when a caviar market was established (Smith and Clugston 1997). Record landings were reported in 1890, where over 3350 metric tons (mt) of Atlantic sturgeon were landed from coastal rivers along the Atlantic Coast (Matthiopoulos and Aarts 2010; Smith and Clugston 1997). Between 1890 and 1905, Atlantic sturgeon populations declined dramatically due to sale of meat and caviar. The majority of these landings (75%) were from the Delaware River fishery, which presumably supported the largest population along the Atlantic Coast (Matthiopoulos and Aarts 2010). Ten years after peak landings, the fishery collapsed in 1901, when less than 10% (295 mt) of its 1890 peak landings were reported. The landings continued to decline to about 5% of the peak until 1920 and remained between 1-5% thereafter. Between 1920 and 1998, the harvest level remained very low due to depleted populations.

Prompted by research on juvenile production between 1985 and 1995 (Peterson et al. 2000), the Atlantic sturgeon fishery was closed by the Atlantic States Marine Fisheries Commission in 1998, when a coastwide fishing moratorium was imposed for 20 to 40 years, or at least until 20 year classes of mature female Atlantic sturgeon were present (ASMFC 1998).

Currently, the only populations that have been studied well enough to provide an estimate of size are from the Hudson and Altamaha Rivers. These two systems are considered the two largest spawning populations on the East Coast. Kahnle et al. (2007) reported that approximately 870 adults per year returned to the Hudson River between 1985 and 1995. Peterson et al. (2010) reported that approximately 324 and 386 adults per year returned to the Altamaha River in 2004 and 2005, respectively. Juvenile Atlantic sturgeon abundance may be a more precise way to measure the status of Atlantic sturgeon populations because it is believed that all age-1 and age-2 juveniles are restricted to their natal rivers (Bain et al. 1999; Dovel and Berggren 1983). Peterson et al. (2000) reported that there were approximately 4,300 age-1 and -2 Atlantic sturgeon in the Hudson River between 1985 and 1995. Schueller and Peterson (2010) reported that age-1 and -2 Atlantic sturgeon population densities ranged from 1,000 to 2,000 individuals over a 4 year period from 2004 to 2007. Abundance data on age 1 cohort data suggest a positive population trend in the Altamaha from 2004-2010 (Peterson and Bednarski 2011).

The Hudson and Altamaha are presumed to be the healthiest populations within the U.S. Thus, other spawning populations within the U.S. are predicted to have fewer than 300 adults spawning per year. However, evaluating the status of the species depends on the status of the smaller extant populations because maintaining those populations maintains genetic heterogeneity and having a broad range prevents a single catastrophic event from causing their extinction.

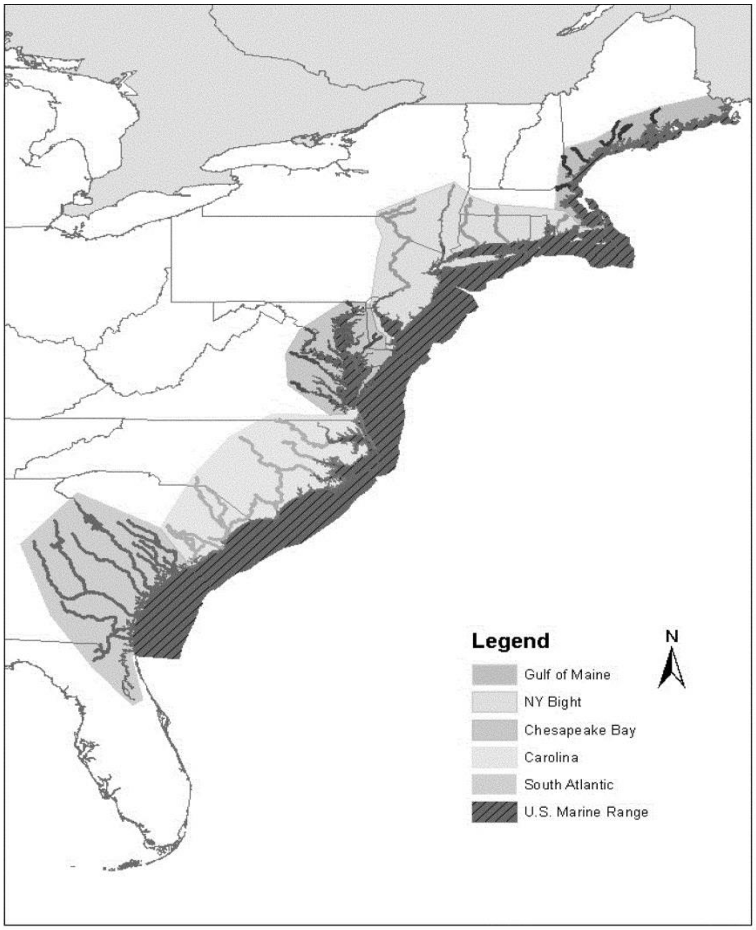

Figure 16. Atlantic Sturgeon Distinct Population Segments (DPS) and Marine Range

4.4.14.7 *Gulf of Maine DPS*

The GOM DPS includes all Atlantic sturgeon whose range occurs in watersheds from the Maine/Canadian border and extending southward to include all associated watersheds draining into the Gulf of Maine as far south as Chatham, MA, as well as wherever these fish occur in coastal bays, estuaries, and the marine environment from the Bay of Fundy, Canada, to the Saint Johns River, FL (See Figure 17). Within this range, Atlantic sturgeon have been documented from the following rivers: Penobscot, Kennebec, Androscoggin, Sheepscot, Saco, Piscataqua, and Merrimack. The Kennebec River is currently the only known spawning river for the GOM DPS. Evidence of Atlantic sturgeon spawning in other rivers of the GOM DPS is not available. However, Atlantic sturgeon continue to use these historical spawning rivers and may represent additional spawning groups (ASSRT, 2007). The majority of historical Atlantic sturgeon spawning habitat is accessible in all but the Merrimack River of the GOM DPS. Therefore, the availability of spawning habitat does not appear to be the reason for the lack of observed spawning in other GOM DPS rivers. However, whether Atlantic sturgeon spawning habitat in the GOM DPS is fully functional is difficult to quantify.

Known threats to Atlantic sturgeon of the GOM DPS include effects to riverine habitat (*e.g.*, dredging, water quality) as well as threats that occur throughout their marine range (*e.g.*, fisheries bycatch). There are no current abundance estimates for the GOM DPS of Atlantic sturgeon. The CPUE of subadult Atlantic sturgeon in a multi-filament gillnet survey conducted on the Kennebec River was considerably greater for the period of 1998-2000 (CPUE=7.43) compared to the CPUE for the period 1977-1981 (CPUE = 0.30). The CPUE of adult Atlantic sturgeon showed a slight increase over the same time period (1977-1981 CPUE = 0.12 versus 1998-2000 CPUE = 0.21) (Squiers, 2004). There is also new evidence of Atlantic sturgeon presence in rivers (*e.g.*, the Saco River) where they have not been observed for many years.

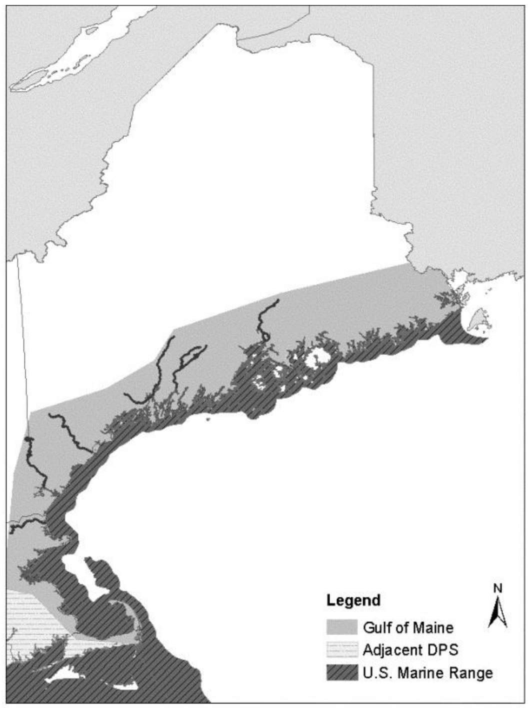

Figure 17. Atlantic Sturgeon, Gulf of Maine DPS

4.4.14.8 ***New York Bight DPS***

The New York Bight (NYB) DPS includes all Atlantic sturgeon whose range occurs in watersheds that drain into coastal waters, including Long Island Sound, the New York Bight, and Delaware Bay, from Chatham, MA to the Delaware-Maryland border on Fenwick Island, as well as wherever these fish occur in coastal bays, estuaries, and the marine environment from the Bay of Fundy, Canada, to the Saint Johns River, FL (See Figure 18). Within this range, Atlantic sturgeon have been documented from the Hudson and Delaware rivers as well as at the mouth of the Connecticut and Taunton rivers, and throughout Long Island Sound. There is evidence to support that spawning occurs in the Hudson and Delaware Rivers. Evidence of Atlantic sturgeon spawning in the Connecticut and Taunton Rivers is not available. However, Atlantic sturgeon continue to use these historical spawning rivers (ASSRT 2007). The majority of historical spawning habitat is accessible to the NYB DPS. Therefore, the availability of spawning habitat does not appear to be the reason for lack of observed spawning in the Connecticut and Taunton

Rivers. However, whether Atlantic sturgeon spawning habitat in these rivers is fully functional is difficult to quantify.

Known threats to Atlantic sturgeon of the NYB DPS include effects to riverine habitat (*e.g.*, dredging, water quality, and vessel strikes) as well as threats that occur throughout their marine range (*e.g.*, fisheries bycatch). The only abundance estimate for Atlantic sturgeon belonging to the NYB DPS is 870 spawning adults per year for the Hudson River subpopulation, based on data collected from 1985-1995 (Kahnle et al. 2007). The accuracy of the estimate may be affected by bias in the reported harvest or estimated exploitation rate for that time period (Kahnle et al. 2007). Underreporting of harvest would have led to underestimates of stock size, while underestimates of exploitation rates would have resulted in overestimates of stock size (Kahnle et al. 2007). In addition, the current number of spawning adults may be higher given that the estimate is based on the time period prior to the moratorium on fishing for and retention of Atlantic sturgeon.

There is no abundance estimate for the Delaware River subpopulation. Delaware's Department of Natural Resources and Environmental Control (DNREC) has been conducting surveys for Atlantic sturgeon since 1991 (DNREC, 2009). Atlantic sturgeon are a Delaware endangered species (state-listed).

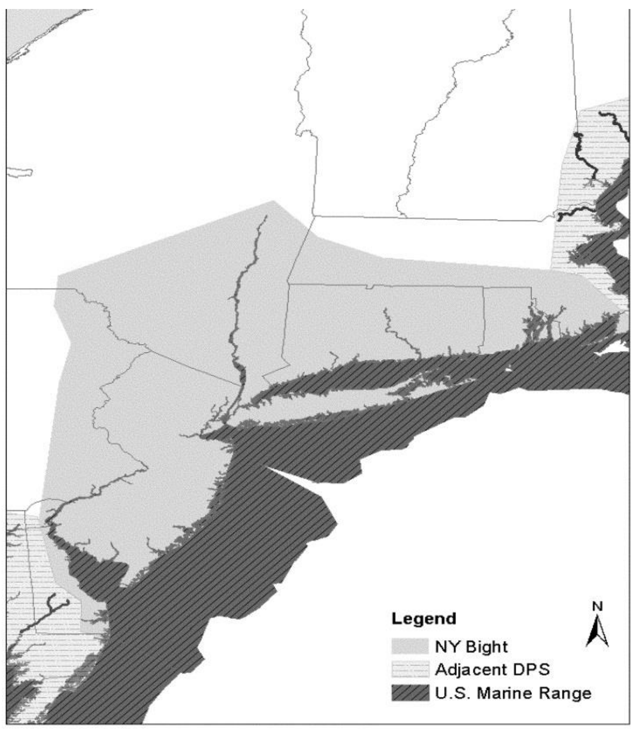

Figure 18. Atlantic Sturgeon, New York Bight DPS

4.4.14.9 ***Chesapeake Bay DPS***

The CB DPS includes all Atlantic sturgeon whose range occurs in watersheds that drain into the Chesapeake Bay and into coastal waters from the Delaware-Maryland border on Fenwick Island to Cape Henry, VA, as well as wherever these fish occur in coastal bays, estuaries, and the marine environment from the Bay of Fundy, Canada, to the Saint Johns River, FL (See Figure 19). Within this range, Atlantic sturgeon have been documented from the James, York, Potomac, Rappahannock, Pocomoke, Choptank, Little Choptank, Patapsco, Nanticoke, Honga, and South rivers as well as the Susquehanna Flats. Historical evidence suggests that several of these, including the James, York, Potomac, Susquehanna, and Rappahannock Rivers, were Atlantic sturgeon spawning rivers. However, the James River is currently the only known spawning river for the CB DPS. Evidence of Atlantic sturgeon spawning in other rivers of the CB DPS is not available, although spawning is suspected to occur in the York based on genetics data and anecdotal reports. The majority of historical Atlantic sturgeon spawning habitat is accessible, but it is unknown whether it is fully functional.

Known threats to Atlantic sturgeon of the CB DPS include effects to riverine habitat (*e.g.,* dredging, water quality, vessel strikes) as well as threats that occur throughout their marine range (*e.g.,* fisheries bycatch). There are no current abundance estimates for the CB DPS. The Maryland Reward Program has resulted in the documentation of over 1,133 wild Atlantic sturgeon since 1996. The Virginia Atlantic sturgeon reward program in the Chesapeake Bay documented and measured 295 Atlantic sturgeon in 1997 and 1998 (Spells, 2007). However, since sturgeon from multiple DPSs occur in the Chesapeake Bay, it is unlikely that all of the sturgeon captured in either reward program originated from the CB DPS.

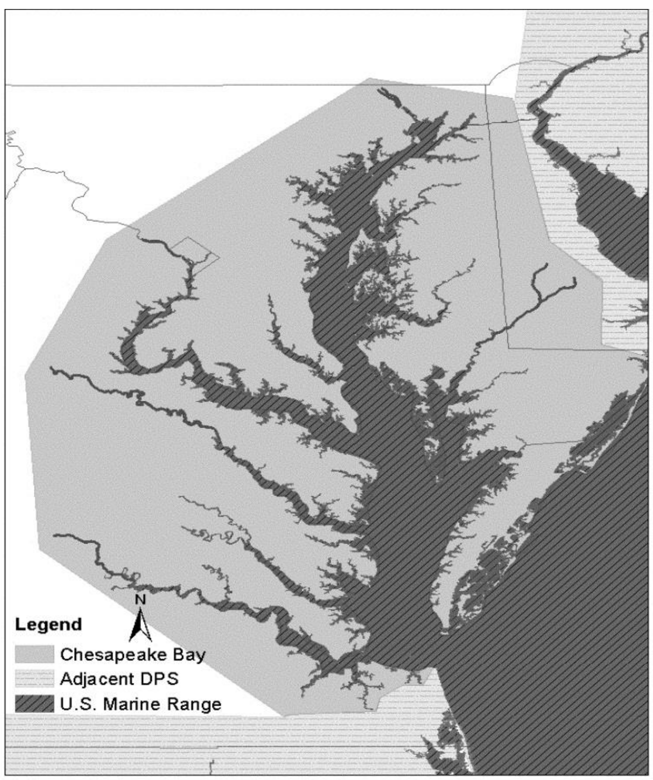

Figure 19. Atlantic Sturgeon, Chesapeake Bay DPS

4.4.14.10 *The Carolina DPS*

The Carolina DPS includes all Atlantic sturgeon that spawn or are spawned in the watersheds (including all rivers and tributaries) from Albemarle Sound southward along the southern Virginia, North Carolina, and South Carolina coastal areas to Charleston Harbor. The marine range of Atlantic sturgeon from the Carolina DPS extends from the Hamilton Inlet, Labrador, Canada, to Cape Canaveral, Florida (See Figure 20). The Carolina DPS also includes Atlantic sturgeon held in captivity (*e.g.*, aquaria, hatcheries, and scientific institutions) and which are identified as fish belonging to the Carolina DPS based on genetics analyses, previously applied tags, previously applied marks, or documentation to verify that the fish originated from (hatched in) a river within the range of the Carolina DPS, or is the progeny of any fish that originated from a river within the range of the Carolina DPS

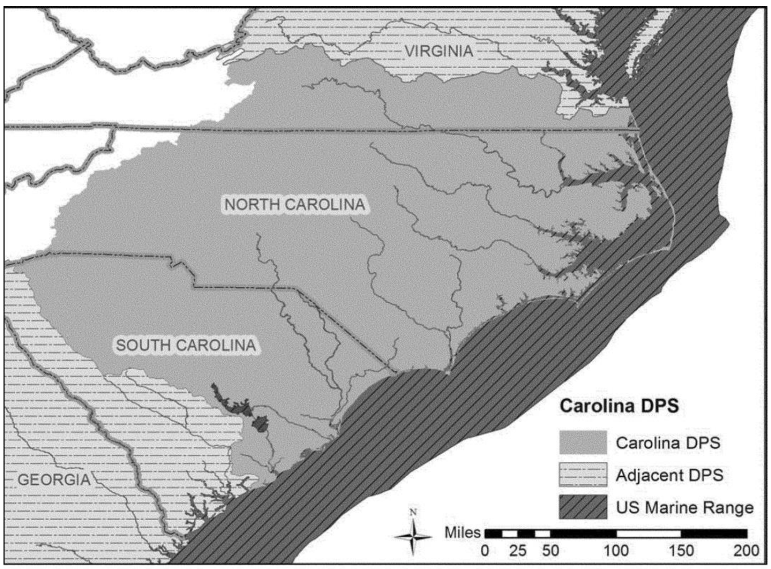

Figure 20. Atlantic Sturgeon, Carolina DPS

4.4.14.11 *South Atlantic DPS*

The South Atlantic DPS includes all Atlantic sturgeon that spawn or are spawned in the watersheds (including all rivers and tributaries) of the ACE (Ashepoo, Combahee, and Edisto) Basin southward along the South Carolina, Georgia, and Florida coastal areas to the St. Johns River, Florida (See Figure 21). The marine range of Atlantic sturgeon from the South Atlantic DPS extends from the Hamilton Inlet, Labrador, Canada, to Cape Canaveral, Florida. The South Atlantic DPS also includes Atlantic sturgeon held in captivity (*e.g.,* aquaria, hatcheries, and scientific institutions) and which are identified as fish belonging to the South Atlantic DPS based on genetics analyses, previously applied tags, previously applied marks, or documentation to verify that the fish originated from (hatched in) a river within the range of the South Atlantic DPS, or is the progeny of any fish that originated from a river within the range of the South Atlantic DPS.

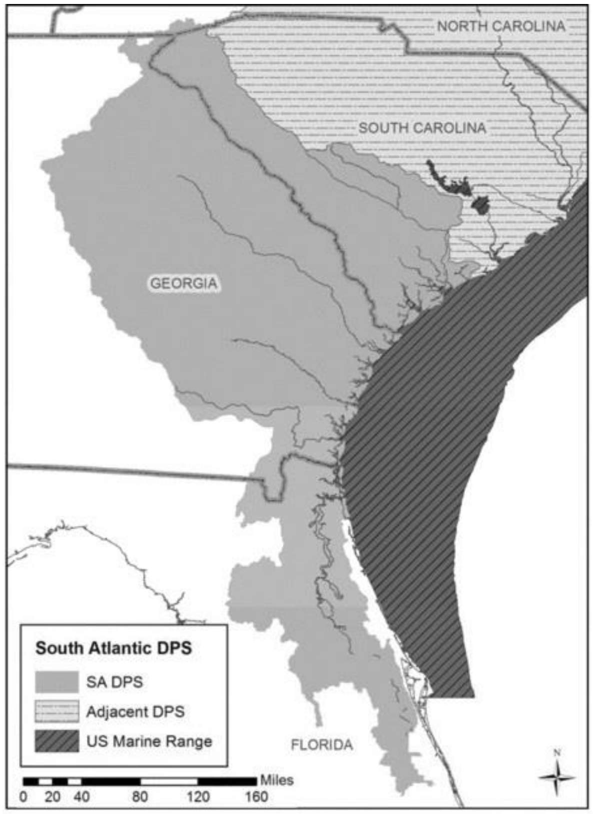

Figure 21. Atlantic Sturgeon, South Atlantic DPS

4.4.14.12 *Natural Threats*

Naturally, these are small populations and in some rivers because of variable spawning returns, Allee affects could be an issue. During all stages of development, Atlantic sturgeon are sensitive to temperatures above 28°C (Niklitschek and Secor 2005) (Anonmyous 2010b; Mcconnell et al. 2010) and dissolved oxygen levels below 4.3 to 4.7 parts per million (EPA 2003; Hindell et al. 2010; Taylor et al. 2010). Juvenile sturgeon are also stressed by high salinities until they mature and out migrate.

4.4.14.13 *Anthropogenic Threats*

Anthropogenic factors likely play a larger role in this species' current status. Water quality, ship strikes, bycatch, dams, and poaching all contribute to the currently depressed populations of Atlantic sturgeon despite having very few natural predators.

The Atlantic Sturgeon Status Review Team (2007) determined Atlantic sturgeon in the Delaware River are at a moderately high risk of extinction because of ship strikes and sturgeon in the James River are at a moderate risk from ship strikes. Since that time, managers in the Hudson River are concerned that ship strikes may also be threatening Atlantic sturgeon populations there. In these systems, large ships move upstream from the mouths of the river to ports upstream through narrow shipping channels. The channels are dredged to the approximate depth of the ships, usually leaving less than 6 feet of clearance between the bottom of ships and the benthos of the river. Because of the size of the propellers used on large ships, everything along the bottom is sucked through the propellers. Large sturgeon are most often killed by ship strikes because smaller fish often pass through the propellers without making contact but larger sturgeon get hit. As shipping increases in the future, as has been predicted by the US Coast Guard, more Atlantic sturgeon are likely to be killed during encounters with ships. Besides the threats to Atlantic sturgeon from ships, the act of dredging the channel can also kill sturgeon. Dredging projects in the Kennebec, Delaware, James, Cape Fear, and Savannah Rivers put Atlantic sturgeon at moderate risk (ASSRT 2007). Dredging primarily affects sturgeon by removing food resources and homogenizing habitat, eliminating holding areas and other high quality habitat. Also, sometimes Atlantic sturgeon are attracted to the sediment plume created during dredging operations and are killed by the dredge itself.

Atlantic sturgeon are caught as bycatch in several fisheries both within river systems and along the coast. In the James River, bycatch in the striped bass fishery poses a moderately high risk to the species, while it poses a moderate risk in nearly every other river system on the East Coast (ASSRT 2007). While these determinations were made for Atlantic sturgeon in each river system, the majority of the commercial fisheries interactions occur in estuaries and along the coast, where sturgeon from all rivers could be captured as bycatch.

On the East Coast, there is no good means of fish passage for Atlantic sturgeon in the systems with dams. Furthermore, as human populations grow along the Atlantic Coast and droughts were common over the past decade, it is likely that many more rivers on the East Coast could be dammed. Sturgeon in the Santee-Cooper River system and the Cape Fear River are at a moderately high risk because of dams. Additionally, sturgeon in the Neuse River are at a moderate risk from dams.

Atlantic sturgeon particularly were overfished during the late 1880s, peaking in 1890 and the fishery collapsed in 1901 (Jehl and Cooper 1980). While the fishery remained open following the initial peak harvest period, landings remained low through the 20th century until 1996 when the fishery was closed due to concerns about the recovery of their populations.

Atlantic sturgeon have also been impacted by industrialization, poor water quality, and loss of habitat (Collins et al. 2002; Jager et al. 2001; Stein et al. 2004; Van Eenennaam et al. 1996). Most Atlantic sturgeon managers and researchers consider water quality as a moderate risk to every DPS in the United States (ASSRT 2007). Atlantic sturgeon are sensitive to pesticides, heavy metals, and other toxins in the aquatic environment.

4.4.14.14 *Critical Habitat*

Critical habitat has not been proposed for Atlantic sturgeon.

4.4.15 **Gulf Sturgeon**

The Gulf sturgeon (*Acipenser oxyrinchus (=oxyrhynchus) desotoi*), also known as the Gulf of Mexico sturgeon, is an anadromous fish (breeding in freshwater after migrating up rivers from marine and estuarine environments), inhabiting coastal rivers from Louisiana to Florida during the warmer months and overwintering in estuaries, bays, and the Gulf of Mexico.

It is a nearly cylindrical primitive fish embedded with bony plates or scutes. The head ends in a hard, extended snout; the mouth is inferior and protrusible and is preceded by four conspicuous barbels. The tail (caudal fin) is distinctly asymmetrical, the upper lobe is longer than the lower lobe (heterocercal). Adults range from 1.2 to 2.4 meters (m) (4 to 8 feet (ft)) in length, with adult females larger than males.

The Gulf sturgeon is distinguished from the geographically disjunct Atlantic coast subspecies (*A. o. oxyrinchus*) by its longer head, pectoral fins, and spleen (Vladykov, 1955; Wooley, 1985). King *et al.* (2001) have documented substantial divergence between *A. o. oxyrinchus* and *A. o. desotoi* using microsatellite DNA testing.

4.4.15.1 ***Distribution and Status***

Historically, the Gulf sturgeon occurred from the Mississippi River east to Tampa Bay (See Figure 22). Its present range extends from Lake Pontchartrain and the Pearl River system in Louisiana and Mississippi east to the Suwannee River in Florida. Sporadic occurrences have been recorded as far west as the Rio Grande River between Texas and Mexico, and as far east and south as Florida Bay (WOOLEY and CRATEAU 1985) (Reynolds, 1993). In the late 19th century and early 20th century, the Gulf sturgeon supported an important commercial fishery, providing eggs for caviar, flesh for smoked fish, and swim bladders for isinglass, a gelatin used in food products and glues (Huff 1975) (Carr, 1983). Gulf sturgeon numbers declined due to overfishing throughout most of the 20th century. The decline was exacerbated by habitat loss associated with the construction of water control structures, such as dams and sills (submerged ridge or vertical wall of relatively shallow depth separating two bodies of water), mostly after 1950. In several rivers throughout the species' range, dams have severely restricted sturgeon access to historic migration routes and spawning areas (WOOLEY and CRATEAU 1985) (Boschung, 1976; and McDowall, 1988).

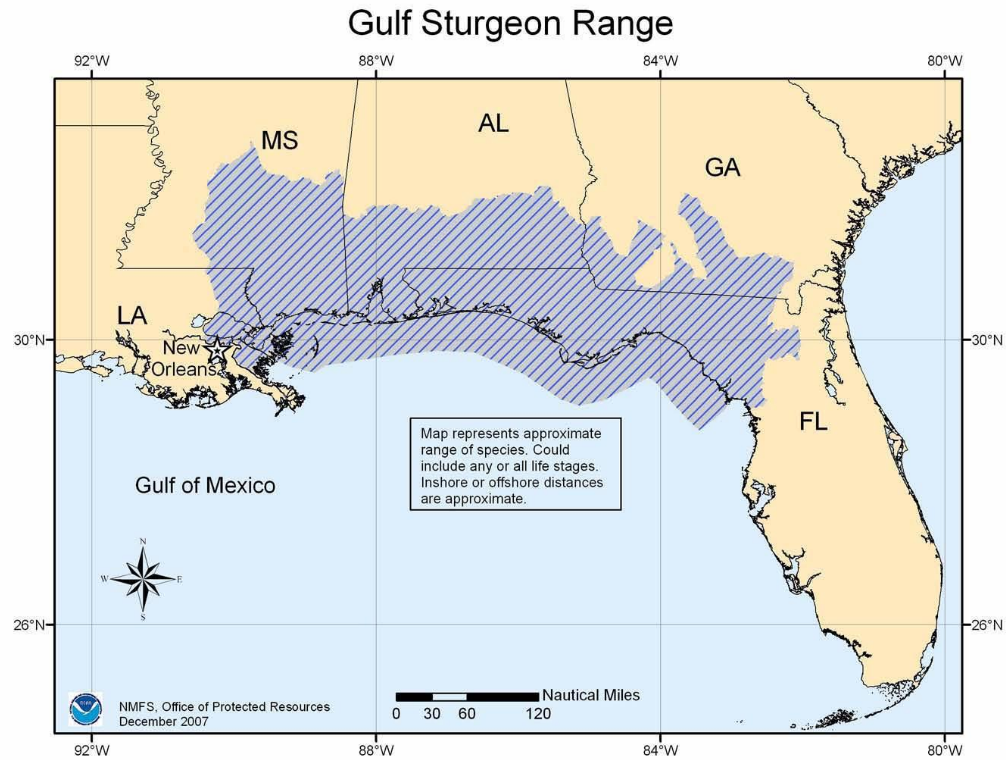

Figure 22. Gulf Sturgeon Range

4.4.15.2 ***Migration***

Migratory behavior of the Gulf sturgeon seems influenced by sex, reproductive status, water temperature, and possibly river flow. Carr *et al.* (1996b) reported that male Gulf sturgeon initiate migration to the river earlier in spring than females. Fox *et al.* (2000b) found no significant difference in the timing of river entry due to sex, but reported that males migrate further upstream than females and that ripe (in reproductive condition) males and females enter the river earlier than non-ripe fish (Fox et al. 2000b). Most adults and subadults begin moving from estuarine and marine waters into the coastal rivers in early spring (*i.e.*, March through May) when river water temperatures range from 16.0 to 23.0 °C (60.8 to 73.4 °C) (Carr 1983; Fox et al. 2000b; Huff 1975; WOOLEY and CRATEAU 1985) (Odenkirk, 1989; Clugston *et al.*, 1995; Foster and Clugston, 1997; Fox and Hightower, 1998; Sulak and Clugston, 1999), while others may enter the rivers during summer months (Fox et al. 2000b). Some research supports the theory that spring migration coincides with the general period of spring high water (Ross et al. 2001) (Chapman and Carr, 1995; Sulak and Clugston, 1999), however, observations on the Choctawhatchee River have not found a clear relationship between the timing of river entrance and flow patterns (Fox *et al.*, 2002).

Downstream migration from fresh to saltwater begins in September (at about 23°C (73.4°F)) and continues through November (Huff 1975; WOOLEY and CRATEAU 1985) Foster and Clugston, 1997). During the fall migration from fresh to saltwater, Gulf sturgeon may require a period of physiological acclimation to changing salinity levels, referred to as osmoregulation or staging (WOOLEY and CRATEAU 1985). This period may be short (Fox *et al.*, 2002) as sturgeon develop an active mechanism for osmoregulation and ionic balance by age one (Altinok et al., 1997). On some river systems, timing of the fall migration appears to be associated with pulses of higher river discharge (Ross et al. 2001) (Heise *et al.*, 1999a and b; Ross *et al.*, 2000 and Parauka *et al.*, in press).

Sturgeon ages 1 through 6 remain in the mouth of the Suwannee River over winter. In late January through early February, young-of-the-year Gulf sturgeon migrate down river for the first time (Sulak and Clugston, 1999). Huff (1975) noted that juvenile Gulf sturgeon in the Suwannee River most likely participated in pre- and post-spawning migrations, along with the adults.

Findeis (1997) described sturgeon (Acipenseridae) as exhibiting evolutionary traits adapted for benthic cruising. Tracking observations by Sulak and Clugston (1999), Fox *et al.* (2002), and Edwards *et al.* (in prep.) support that individual fish move over an area until they encounter suitable prey type and density, at which time they forage for extended periods of time. Individual fish often remained in localized areas (less than 1 km_2 (0.4 mi_2) for extended periods of time (greater than two weeks) and then moved rapidly to another area where localized movements occurred again (Fox *et al.*, 2002). It is unknown precisely how much benthic area is needed to sustain Gulf sturgeon health and growth, but because Gulf sturgeon have been known to travel long distances (greater than 161 km (100 mi)) during their winter feeding phase, significant resources must be necessary.

These winter migrations are an important strategy for feeding and for occasional travel to non-natal rivers for possible spawning and resultant genetic interchange among subpopulations. Bays and portions of Gulf of Mexico waters adjacent to the lakes and bays near the mouths of the rivers where Gulf sturgeon occur are believed to be important for feeding and/or migrating (inter-river migrations that facilitate maintenance of the natural hierarchy of between river genetic variability).

When temperature drops occur that are associated with major cold fronts, researchers of the Escambia, Yellow, and Suwannee Rivers subpopulations have been unable to locate adult Gulf sturgeon within the bays (Craft *et al.*, 2001; and Edwards *et al.*, in prep.). They hypothesize that the drop in water temperatures associated with cold fronts disperses sturgeon to more distant foraging grounds. It is currently unknown whether Gulf sturgeon undertake extensive offshore migrations, and further study is needed to determine whether important winter feeding habitat occurs in farther offshore areas.

Sulak and Clugston (1999) described two hypotheses regarding areas adult Gulf sturgeon may overwinter in the Gulf of Mexico in order to find abundant prey. The first hypothesis is that Gulf sturgeon spread along the coast in nearshore waters in depths less than 10 m (33 ft). The alternative hypothesis is that they migrate far offshore to the broad sedimentary plateau in deep water (40 to 100 m (131 to 328 ft)) west of the Florida Middle Grounds, where over twenty species of bottom-feeding fish congregate in the winter (Darnell and Kleypas, 1987). Available data support the first hypothesis. Evaluation of tagging data has identified several nearshore Gulf of Mexico feeding migrations, but no offshore Gulf of Mexico feeding migrations or areas. Telemetry data document that Gulf sturgeon from the Pearl River and Pascagoula River subpopulations migrate from their natal bay systems to Mississippi Sound and move along the barrier islands, with relocation of tagged individuals greatest in the passes between islands (Ross et al. 2001) (Rogillio *et al.*, 2002).

Gulf sturgeon from the Choctawhatchee River, Yellow River, and Apalachicola River have been documented migrating in the nearshore Gulf of Mexico waters between Pensacola and Apalachicola Bays (Fox *et al.*, 2002; and F. Parauka, pers. comm. 2002). Telemetry data in the Gulf of Mexico usually locate sturgeon in depths of 6 m (19.8 ft) or less (Ross et al. 2001) (Fox *et al.*, 2002; Rogillio *et al.*, 2002; and F. Parauka, pers. comm. 2002).

4.4.15.3 *River-Specific Fidelity*

Stabile *et al.* (1996) analyzed tissue from Gulf sturgeon in eight drainages along the Gulf of Mexico for genetic diversity. They noted significant differences among Gulf sturgeon stocks and suggested that they displayed region-specific affinities and may exhibit river-specific fidelity. Stabile *et al.* (1996) identified five regional or river-specific stocks (from west to east): (1) Lake Pontchartrain and Pearl River, (2) Pascagoula River, (3) Escambia and Yellow Rivers, (4) Choctawhatchee River, and (5) Apalachicola, Ochlockonee, and Suwannee Rivers.

Tagging studies suggest that Gulf sturgeon exhibit a high degree of river fidelity (Carr 1983). From 1981 to 1993, 4,100 fish were tagged in the Apalachicola and Suwannee Rivers. Of these, 868 total fish were recaptured (USFWS and GSMFC 1995). Of the recaptured fish, 860 fish (99 percent) were recaptured in the river of their initial collection. Eight fish moved between river systems and represented less than 1 percent (0.009) of the 868 total fish recaptured (USFWS and GSMFC 1995). We have no information documenting spawning adults in non-natal rivers. Foster and Clugston (1997) noted that telemetered Gulf sturgeon in the Suwannee River returned to the same areas as the previous summer, and suggested that chemical cuing may influence distribution.

To date, biologists have documented a total of 22 Gulf sturgeon making interriver movements from natal rivers. They are as follows: Apalachicola River to Suwannee River, six Gulf sturgeon (Carr *et al.*, 1996b); Apalachicola River to Deer Point Lake (North Bay of the St. Andrew Bay system), one fish (Wooley and Crateau, 1985); Suwannee River to Apalachicola River, three sturgeon (Carr *et al.*, 1996b; and F. Parauka, pers. comm. 2002); Choctawhatchee River to Apalachicola River, one sturgeon (F. Parauka, pers. comm. 2002); Yellow River to Choctawhatchee River, three female sturgeon (two adult, one subadult) (Craft *et al.*, 2001); Yellow River to Louisiana Estuarine area, one female sturgeon (Craft *et al.*, 2001); Escambia River to Yellow River, one mature female on spawning grounds (Craft *et al.*, 2001); Suwannee River to Ochlockonee River, one sturgeon (USFWS and GSMFC 1995); Choctawhatchee River to Escambia River, one male sturgeon (Fox *et al.*, 2002); Choctawhatchee River to Escambia, one female sturgeon (Fox *et al.*, 2002); Pearl River (Bogue Chitto) to Pascagoula River, one sturgeon (Ross et al. 2001); Choctawhatchee River to Pascagoula River, one subadult sturgeon (Ross et al. 2001); and Pascagoula River to Yellow River, one sturgeon (Ross et al. 2001). Tallman and Healey (1994) noted that observed straying rates between rivers were not the same as actual gene flow rates, *i.e.*, inter-stock movement does not equate to interstock reproduction.

The gene flow is low in Gulf sturgeon stocks, with each stock exchanging less than one mature female per generation (Waldman and Wirgin 1998).

4.4.15.4 ***Feeding Habits***

Gulf sturgeon feeding habits in freshwater vary depending on the fish's life history stage (*i.e.*, young-of-the-year, juvenile, subadult, adult). Young-of-the-year Gulf sturgeon remain in freshwater feeding on aquatic invertebrates and detritus approximately 10 to 12 months after spawning occurs (Mason and Clugston, 1993; and Sulak and Clugston, 1999). Juveniles (less than 5 kg (11 lbs) are believed to forage extensively and exploit scarce food resources throughout the river, including aquatic insects (*e.g.*, mayflies and caddisflies), worms (oligochaetes), and bivalve molluscs (Huff 1975) (Mason and Clugston, 1993). Juvenile (ages 1 to 6) Gulf sturgeon collected in the Suwannee River are trophically active (foraging) near the river mouth at the estuary, but trophically dormant (not foraging) in summer holding areas upriver. A portion of the juvenile population reside and feed year round near the river mouth at the estuary, not just in winter (K. Sulak, U.S. Geological Survey (USGS), pers. comm. 2002). In the Choctawhatchee River, juvenile (ages 1 to 6) Gulf sturgeon did not remain near the estuary at the river mouth for the entire year, instead, they were located during winter months in Choctawhatchee Bay and returned upriver to resting areas in the spring (F. Parauka, FWS, pers. comm. 2002). Subadult (age 6 to sexual maturity) and adult (sexually mature) Gulf sturgeon do not feed in freshwater (WOOLEY and CRATEAU 1985) (Mason and Clugston, 1993).

Many reports indicate that adult and subadult Gulf sturgeon lose a substantial percentage of their body weight while in freshwater (WOOLEY and CRATEAU 1985) Mason and Clugston, 1993; and Clugston *et al.*, 1995) and then compensate the loss during winter feeding in the estuarine and marine environments (WOOLEY and CRATEAU 1985) Clugston *et al.*, 1995). Gu *et al.* (2001) tested the hypothesis that subadult and adult Gulf sturgeon do not feed significantly during their annual residence in freshwater by comparing stable carbon isotope ratios of tissue samples from subadult and adult Suwannee River Gulf sturgeon and their potential freshwater and marine food sources. A large difference in isotope ratios between freshwater food sources and fish muscle tissue suggests that subadult and adult Gulf sturgeon do not feed significantly in freshwater. The isotope similarity between Gulf sturgeon and marine food resources strongly indicates that this species relies almost entirely on the marine food web for its growth (Gu *et al.*, 2001).

Once subadult and adult Gulf sturgeon leave the river, having spent at least 6 months in the river fasting, we presume that they immediately begin feeding. Upon exiting the rivers, Gulf sturgeon are found in high concentrations near their natal river mouths. Lakes and bays at the mouths of the river systems where Gulf sturgeon occur are important because they offer the first opportunity for Gulf sturgeon exiting their natal rivers to forage. Gulf sturgeon must be able to consume sufficient quantities of prey while in estuarine and marine waters to regain the weight they lose while in the river system and to maintain positive growth on a yearly basis. In addition, reproductively active Gulf sturgeon require additional food resources to obtain sufficient energy necessary for reproduction (Fox *et al.*, 2002; and D. Murie and D. Parkyn, University of Florida (UF), pers. comm. 2002).

Adult and subadult Gulf sturgeon, while in marine and estuarine habitat, are thought to forage opportunistically (Huff 1975), primarily on benthic (bottom dwelling) invertebrates. Gut content analyses have indicated that the Gulf sturgeon's diet is predominantly amphipods, lancelets, polychaetes, gastropods, shrimp, isopods, molluscs, and crustaceans (Fox et al. 2000b; Huff 1975) Mason and Clugston, 1993; Carr *et al.*, 1996b; Fox *et al.*, 2002). Gulf sturgeon from the Suwannee River subpopulation are known to forage on brachiopods (Murie and Parkyn, pers. comm. 2002); however, this is not a documented prey item of other subpopulations. Ghost shrimp (*Lepidophthalmus louisianensis*) and the haustoriid amphipod (*Lepidactylus* spp.) are strongly suspected to be important prey for adult Gulf sturgeon over 1 m (3.3 ft) (Heard *et al.*, 2000; and Fox *et al.*, 2002). This hypothesis is based on the following evidence: (1) Gulf sturgeon have been consistently located and observed actively feeding in areas where numerous burrows similar to those occupied by ghost shrimp exist (Fox et al. 2000b) and in areas having a high density of ghost shrimp and haustoriid amphipods (Heard *et al.*, 2000), (2) the digestive tracts of two adult Gulf sturgeon that died during netting operations contained numerous ghost shrimp (Fox et al. 2000b), (3) stomach contents of a 30 kg (67 lb) sturgeon taken in the upper portion of Choctawhatchee Bay contained more than 100 individual haustoriid amphipods and 67 ghost shrimp (Heard *et al.*, 2000), and (4) approximately one-third of 157 sturgeon guts analyzed by Carr *et al.* (1996b) contained exclusively brachiopods and ghost shrimp.

4.4.15.5 ***Reproduction***

Gulf sturgeon are long-lived, with some individuals reaching at least 42 years in age (Huff 1975). Age at sexual maturity for females ranges from 8 to 17 years, and for males from 7 to 21 years (Huff 1975). Gulf sturgeon eggs are demersal (they are heavy and sink to the bottom), adhesive, and vary in color from gray to brown to black (Huff 1975){Vladykov, 1963 #149471}(Parauka *et al.*, 1991). Chapman *et al.* (1993) estimated that mature female Gulf sturgeon weighing between 29 and 51 kg (64 and 112 lb) produce an average of 400,000 eggs. Habitat at egg collection sites consists of one or more of the following: limestone bluffs and outcroppings, cobble, limestone bedrock covered with gravel and small cobble, gravel, and sand (Fox et al. 2000b; Marchant and Shutters 1996) (Sulak and Clugston, 1999; Heise *et al.*, 1999a; and Craft *et al.*, 2001). On the Suwannee River, Sulak and Clugston (1999) suggest a dense matrix of gravel or cobble is likely essential for Gulf sturgeon egg adhesion and the sheltering of the yolk sac larvae, and is a habitat spawning adults apparently select. Other substrates identified as possible spawning habitat include marl (clay with substantial calcium carbonate), soapstone, or hard clay (W. Slack, Mississippi Museum of Natural Science (MMNS), pers. comm. 2002; and F. Parauka, pers. comm. 2002).

Water depths at egg collection sites ranged from 1.4 to 7.9 m (4.6 to 26 ft), with temperatures ranging from 18.2 to 23.9 degrees Celsius (°C) (64.8 to 75.0 degrees Fahrenheit (°F)) (Fox et al. 2000b) (Ross *et al.*, 2000; Craft *et al.*, 2001). Laboratory experiments indicated optimal water temperature for survival of Gulf sturgeon larvae is between 15 and 20 °C (59 and 68 °F), with low tolerance to temperatures above 25 °C (77 °F) (Chapman and Carr, 1995).

Researchers hypothesize that spawning must take place where the hydrological and chemical settings are appropriate for gamete (mature reproductive cell) function, and temperature, pH, and dissolved oxygen (DO) conditions are stable and appropriate for embryonic and yolk sac larval development (Sulak and Clugston, 1999).

Sulak and Clugston (1999) suggested that sturgeon spawning activity in the Suwannee River is related to the phase of the moon, but only after the water temperature has risen to 17 °C (62.6 °F). Other researchers however, have found little evidence of spawning associated with lunar cycles (Fox et al. 2000b) (Slack *et al.*, 1999). Spawning in the Suwannee River occurs during the general period of spring high water, when ionic conductivity and calcium ion concentration are most favorable for egg development and adhesion (Sulak and Clugston, 1999). Fox *et al.* (2002) found no clear pattern between timing of Gulf sturgeon entering the river and flow patterns on the Choctawhatchee River. Ross *et al.* (Ross et al. 2001) surmised that the high flows in early March were a cue for sturgeon to begin their upstream movement in the Pascagoula River.

Atlantic sturgeon (*A. oxyrinchus*) exhibit a long inter-spawning period, with females spawning at intervals ranging from every 3 to 5 years, and males every 1 to 5 years (Smith 1985). It is believed that Gulf sturgeon exhibit similar spawning periodicity, as male Gulf sturgeon are capable of annual spawning, and females require more than one year between spawning events (Fox et al. 2000b; Huff 1975).

4.4.15.6 ***Threats to Gulf Sturgeon***

The 1991 listing rule cited the following impacts and threats:

- Dams on the Pearl, Alabama, and Apalachicola rivers; also on the North Bay arm of St. Andrews Bay
- Channel improvement and maintenance activities: dredging and de-snagging
- Water quality degradation
- Contaminants

4.4.15.7 ***Threats to Habitat – Dams***

All of the dams noted in the listing rule continue to block passage of Gulf sturgeon to historical spawning habitats and thus either reduce the amount of available spawning habitat or entirely impede access to it. Since Gulf sturgeon were listed, several new dams have been proposed on rivers that support Gulf sturgeon. Effects of these dams on Gulf sturgeon and their habitat continues to be investigated as well as potential mitigating factors, including assessing the effects of dam operations, on downstream habitats. A short summary of these efforts follows.

Biologists from Clemson University, Georgia Department of Natural Resources, FWS, NMFS, and the Corps are investigating the feasibility of fish passage at Jim Woodruff Lock and Dam on the Apalachicola River (Isely et al. 2005 – workshop presentation). While Gulf sturgeon do not appear to enter the lock, Alabama shad and striped bass have utilized the lock to pass upstream. At this time, it is still unclear whether upstream sturgeon passage through the lock is feasible and if passage would result in a conservation benefit to the Gulf sturgeon. A study using hatchery-reared Gulf sturgeon tagged and released above the Dam into Lake Seminole found that some fish passed downstream into the Apalachicola River, possibly through the navigation lock, while others remained in the reservoir (Weller 2002). None of the tagged fish were observed to travel upstream to areas of potential spawning habitats.

Two dams, Pools Bluff and Bogue Chitto Sills, also impact Gulf sturgeon movements in the Pearl River drainage. Upstream passage is likely possible over these structures during some flow conditions, but the extent to which passage occurs is still unknown. New studies to survey the Pearl River for Gulf sturgeon and track movements began in summer 2009 (S. Bolden, NMFS, pers. com).

The effects on Gulf sturgeon from the Corps' operation of Federal dams and reservoirs in the Apalachicola River basin were assessed in recent biological opinions (USFWS 2006a, 2007, and 2008). The latest of these opinions concluded that some lethal take of Gulf sturgeon eggs or larvae could occur under certain circumstances of rapidly declining river stages during the spawning season. Based on further analysis of flow records and operational practices, the Corps determined that it appears feasible to operate the system in a manner that would avoid take of eggs and larvae in most, if not all, circumstances (USACE 2009). Flowers et al. (in press) examined the possibility of reduced recruitment associated with low flows in the Apalachicola River system and suggested that decreased spawning habitat availability could prolong population recovery or reduce population viability.

Except for the proposed dams on the Pearl River and the Yellow River, the dams listed in the table below would be constructed upstream of both designated Gulf sturgeon critical habitat and areas known to be inhabited by Gulf sturgeon. However, if constructed these dams/reservoirs could alter flow, channel morphology, and water quality well downstream and within designated critical habitat.

Table 37. Summary of Dams Proposed Within the Geographic Range of Gulf Sturgeon by River Drainage

Drainage Basin	State	Stream	Notes
Pearl	MS	Mainstem	Proposed LeFleur Lakes reservoir near Jackson, MS, in vicinity of possible sturgeon spawning area.
Escambia/Conecuh	AL	Murder Creek	Proposed reservoir site is on a tributary that joins the Conecuh River near a known summer resting area for sturgeon.
Escambia/Conecuh	AL	Big Escambia Creek	Proposed reservoir site is on a tributary that joins the Escambia River near the FL/AL border.
Choctawhatchee	AL	Little Choctawhatchee River	Proposed reservoir site is on a tributary that joins the Choctawhatchee River upstream of known spawning sites.
Yellow	FL	Mainstem	Feasibility study completed by Corps for proposed site near Milligan, FL. Dam would impede passage to known

			spawning site upstream in AL.
Apalachicola	GA	Various	There have been various proposals for new water supply reservoirs, all upstream of the Jim Woodruff Dam on the FL/GA border.

In summary, access to historic Gulf sturgeon spawning habitat continues to be blocked by existing dams and the ongoing operations of these dams also effect downstream habitat. Several new dams are being proposed that would increase these threats to the Gulf sturgeon and its habitat. Dams continue to impede access to upstream spawning areas, and continue to adversely affect downstream habitat including both spawning and foraging areas.

4.4.15.8 *Threats to Habitat – Dredging*

Riverine, estuarine, and coastal navigation channels are often dredged to support commercial shipping and recreational boating. Dredging activities can pose significant impacts to aquatic ecosystems by: 1) direct removal/burial of organisms; 2) turbidity/siltation effects; 3) contaminant re-suspension; 4) noise/disturbance; 5) alterations to hydrodynamic regime and physical habitat; and 6) loss of riparian habitat (Chytalo 1996, Winger et al. 2000).

Dredging operations may also destroy benthic feeding areas, disrupt spawning migrations, and re-suspend fine sediments causing siltation over required substrate in spawning habitat. Because Gulf sturgeon are benthic omnivores, the modification of the benthos affects the quality, quantity, and availability of prey.

Maintenance dredging for the navigation channel on the Apalachicola River last occurred in 2001. Although the channel is still authorized as a Federal navigation project, the State of Florida denied the Corps' application for water quality certification in 2005 (letter dated 11 October 2005 from FDEP Secretary Colleen Castille to Curtis Flakes, USACE). It appears unlikely that periodic or routine dredging in the inland waterway would resume in the reasonably foreseeable future. However, occasional maintenance dredging near the mouth of the Apalachicola River still occurs for that segment, which is part of the Gulf Intra-Coastal Waterway.

Maintenance dredging occurs regularly in numerous navigation channels that traverse the bays, passes, and river mouths of all seven river drainages that are used by Gulf sturgeon. Most of this dredging occurs within designated Gulf sturgeon critical habitat and may modify foraging habitat as well as causing injury or killing Gulf sturgeon.

In summary, dredging and disposal to maintain navigation channels, and removal of sediments for beach re-nourishment occurs frequently and throughout the range of the Gulf sturgeon and within designated Gulf sturgeon habitat annually. This activity has, and continues to threaten the species and affect its designated critical habitat.

4.4.15.9 *Threats to Habitat – Point and Non-point Source Discharges*

Evaluations of water and sediment quality in Gulf Sturgeon habitat on the northern Gulf of Mexico coast, have consistently shown elevated pollutant loading. This has been observed in both tidal coastal rivers of the type that the sturgeon use in the spring and summer (Hemming et al. 2006, 2008). Perhaps better understood is the widespread contamination throughout the overwintering feeding habitat of the Gulf sturgeon (Brim 1998, 2000, NWFWMD 1997, 1998, 2000, 2002, Hemming 2002, 2003a, 2003b, 2004, 2007). Although the specific effects of these widely varied pollutants on sturgeon in their various life stages is not clearly understood, there is ample evidence summarized below to show potential deleterious effects to Gulf sturgeon and their habitat.

Sulak et al. (2004) suggest that successful egg fertilization for Gulf sturgeon may require a relatively narrow range of pH and calcium ion concentration. These parameters vary substantially along the length of the Suwannee River. Egg and larval development are also vulnerable to various forms of pollution and other water quality parameters (e.g., temperature, dissolved oxygen (DO)).

Potential threats to Gulf sturgeon critical habitat were documented in the upper Choctawhatchee and lower Pea Rivers (Popp and Parauka 2004, Newberry and Parauka in press). Potential habitat threats were identified based on degraded habitat characteristics, such as erosion, riparian condition, presence of unpaved roads, and presence of agriculture.

Pollution from industrial, agricultural, and municipal activities is believed responsible for a suite of physical, behavioral, and physiological impacts to sturgeon worldwide (Agusa et al. 2004; Bickman et al. 1998; Kajiwara and N. 2003; Khodorevskaya et al. 1997) (Karpinsky 1992, Barannikova 1995, Barannikova et al. 1995, Khodorevskaya and Krasikov 1999, Billard and Lecointre 2001). Although little is known about contaminant effects on Gulf Sturgeon, a review estimating potential reactions has been performed (Berg 2006). It was found that loss of habitat associated with pollution and contamination has been documented for sturgeon species (Verina and Peseridi 1979, Shagaeva et al. 1993, Barannikova et al. 1995). Specific impacts of pollution and contamination on sturgeon have been identified to include muscle atrophy, abnormality of gonad, sperm and egg development, morphogenesis of organs, tumors, and disruption of hormone production (Dovel et al. 1992; Khodorevskaya et al. 1997; Kruse and Scarnecchia 2002a; Kruse and Scarnecchia 2002b) (Graham 1981, Altuf'yev et al. 1992, Georgi 1993; Romanov and Sheveleva 1993, Heath 1995). The extreme of this situation can be observed in the Caspian Sea, likely the most polluted sturgeon habitat in the world. Researchers there have suggested that nearly 90% of sturgeon suffer from organ pathologies and decreased physiological condition associated with sub-lethal levels of pollution (Akimova and Ruban 1996; Kajiwara and N. 2003) (Veshchev 1995, Luk'yanenko et al. 1999). In addition, nearly 20% of the female sturgeon experience some impact to egg development. Although there has been a reduction in pollution export into the Caspian Sea, the severity of past pollution and nature of the pollutants ensure their presence in the sediments, water column, and tissues of organisms will continue.

More recently, pharmaceuticals and other endocrinologically active chemicals have been found in fresh and marine waters at effective concentrations (reviewed in Fent *et al.* 2006). These compounds enter the aquatic environment via wastewater treatment plants, agricultural facilities, and farm runoff (Folmar et al. 1996, Culp et al. 2000, Wildhaber et al. 2000, Wallin et al. 2002). These products are the source of both natural and synthetic substances including, but not limited to, polychlorinated biphenyls, phthalates, pesticides, heavy metals, alkylphenols, polycyclic aromatic hydrocarbons, 17β-estradiol, 17α-ethinylestradiol, and bisphenol A (Pait and Nelson 2002, Aguayo et al. 2004, Nakada et al. 2004, Iwanowicz et al. 2009, Björkblom et al. 2009). The impact of these exposures on Gulf sturgeon is unknown, but other species of fish are affected in rivers and streams. For example, one major class of endocrine disrupting chemicals, estrogenic compounds, have been shown to affect the male to female sex ratio in fish in streams and rivers via decreased gonad development, physical feminization, and sex reversal (Folmar et al. 1996). Settlement of these contaminants to the benthos may affect benthic foragers to a greater extent than pelagic foragers due to foraging strategies (Geldreich and Clarke 1966).

Several characteristics of the Gulf sturgeon (i.e., long lifespan, extended residence in riverine and estuarine habitats, benthic predator) predispose the species to long-term and repeated exposure to environmental contamination and potential bioaccumulation of heavy metals and other toxicants. Chemicals and metals such as chlordane, DDE, DDT, dieldrin, PCBs, cadmium, mercury, and selenium settle to the river bottom and are later incorporated into the food web as they are consumed by benthic feeders, such as sturgeon or macroinvertebrates. Some of these compounds may affect physiological processes and impede the ability of a fish to withstand stress, while simultaneously increasing the stress of the surrounding environment by reducing DO, altering pH, and altering other water quality properties.

While laboratory results are not available for Gulf sturgeon, signs of stress observed in shortnose sturgeon exposed to low DO included reduced swimming and feeding activity coupled with increased ventilation frequency (Campbell and Goodman 2004). Niklitschek (2001) observed that egestion levels for Atlantic and shortnose sturgeon juveniles increased significantly under hypoxia, indicating that consumed food was incompletely digested. Behavioral studies indicate that Atlantic and shortnose sturgeon are quite sensitive to ambient conditions of oxygen and temperature: in choice experiments juvenile sturgeons consistently selected nomoxic over hypoxic conditions (Niklitschek 2001). Beyond escape or avoidance, sturgeons respond to hypoxia through increased ventilation, increased surfacing (to ventilate relatively oxygen-rich surficial water), and decreased swimming and routine metabolism (Crocker and Cech 1997; Niklitschek 2001; Secor and Gunderson 1998) (Nonnette et al. 1993).

The majority of published data regarding contaminants and sturgeon health are limited to reports of tissue concentration levels. While these data are useful and allow for comparison between individuals, species, and regions, they do not allow researchers to understand the impacts of the concentrations. There is expectation that Gulf sturgeon are being negatively impacted by organic and inorganic pollutants given high concentration levels (Berg 2006). Gulf sturgeon collected from a number of rivers between 1985 and 1991 were analyzed for pesticides and heavy metals (Bateman et al. 1994); concentrations of arsenic, mercury, DDT metabolites, toxaphene, polycyclic aromatic hydrocarbons, and aliphatic hydrocarbons were sufficiently high to warrant concern. More recently, 20 juvenile Gulf sturgeon from the Suwannee River, FL, exhibited an increase in metals concentrations with an increase in individual length (Alam et al. 2000).

Federal and state water quality standards are protective of most taxa in many habitats. However, impacts of reduced water quality continue to be realized at species-specific, and habitat-specific scales and magnification through the trophic levels continues to be assessed. The result is that current water quality standards are not always protective of federally listed species (Augsburger et al. 2003, Augsburger et al. 2007). To compound the issue, many previously identified water quality problems as realized through violation of state water quality standards are addressed through the necessarily slow and deliberate process of regulated point, and non-point source, pollutant load reductions (Total Maximum Daily Loads, TMDLs) for chemicals that have specific quality criteria. Because there are thousands of chemicals interacting in our natural environment, many of them of human design, many do not have Federal or state water quality standards associated with them. Further, effects of most of these chemicals on the Gulf sturgeon or other protected species are poorly understood. For these reasons point and non-point discharges to the Gulf sturgeon's habitat continue to be a threat.

4.4.15.10 *Threats to Habitat – Climate Change*

Climate change has potential implications for the status of the Gulf sturgeon through alteration of its habitat. The Intergovernmental Panel on Climate Change (IPCC 2007) concluded that it is very likely that heat waves, heat extremes, and heavy precipitation events over land will increase during this century. Warmer water, sea level rise and higher salinity levels could lead to accelerated changes in habitats utilized by Gulf sturgeon. Saltwater intrusion into freshwater systems could negatively impact freshwater fish and wildlife habitat (FWC 2009) resulting in more saline inland waters that may eventually lead to major changes in inland water ecosystems and a reduction in the amount of available freshwater. Changes in water temperature may alter the growth and life history of fishes, and even moderate changes can make a difference in distribution and number (FWC 2009). Freshwater habitats can be stressed by changes in both water quality and levels because of anticipated extreme weather periods as mean precipitation is expected to decrease along with an increase in precipitation intensity. Both droughts and floods could become more frequent and more severe, which would affect river flow, water temperature, water quality, channel morphology, estuarine salinity regimes, and many other habitat features important to the conservation of Gulf sturgeon.

A rise in water temperature may create conditions suitable for invasive and exotic species. Higher water temperatures combined with increased nutrients from storm runoff may also result in increased invasive submerged and emergent water plants and phytoplankton which are the foundation of the food chain (FWC 2009). New species of freshwater fishes may become established with warmer water temperatures (FWC 2009). The rate that climate change and corollary impacts are occurring may outpace the ability of the Gulf sturgeon to adapt given its limited geographic distribution and low dispersal rate.

4.4.15.11 *Overutilization for Commercial, Recreational, Scientific, or Educational purposes*

All directed fisheries of Gulf sturgeon have been closed since 1972 in Alabama, 1974 in Mississippi, 1984 in Florida, and 1990 in Louisiana (USFWS 1995). Overutilization due to directed harvest is no longer a threat. Although confirmed reports are rare, it is still a common opinion among Gulf sturgeon researchers that possibly significant Gulf sturgeon mortality occurs as bycatch in fisheries directed at other species. Berg et al. (2004) noted finding a dead juvenile Gulf sturgeon on a trot line in the Blackwater River.

4.4.15.12 *Inadequacy of Existing Regulatory Mechanisms*

Direct take of Gulf sturgeon is still prohibited in all four states within the current range of the species. However, fisheries directed at other species that employ various trawling and entanglement gear in areas that sturgeon regularly occupy pose a risk of incidental bycatch. One such fishery is directed at gars (family Lepisosteidae) in southeast Louisiana, where Gulf sturgeon mortality in entanglement gear has been observed (D. Walther, USFWS, pers. comm.). Louisiana Wildlife and Fisheries Commission staff proposed a ban on commercial netting freshwater areas of southeast Louisiana (the Florida Parishes which include East Baton Rouge, East Feliciana, West Feliciana, Livingston, St. Helena, St. Tammany, Tangipahoa, and Washington) in September 2006. The ban was intended to reduce the incidental bycatch of Gulf sturgeon. The resolution was not adopted.

Relocation trawling associated mostly with channel dredging and beach nourishment projects, which was initially intended to remove sea turtles in close proximity to dredges, has successfully moved several Gulf sturgeon in recent years. Between January 2005 and April 2006 relocation trawling captured and successfully moved two Gulf sturgeon near Mobile Bay, AL: 5 near Gulf Shores, AL, 1 near Destin, FL, and 8 near Panama City Beach, FL. These captures in near-shore waters illustrate the relative vulnerability of Gulf sturgeon to incidental bycatch in fisheries that use trawls. Bycatch in shrimp trawls has been documented but has likely been mitigated by sea turtle and fish excluder devices. However, informal conversations with shrimpers suggest that Gulf sturgeon are commonly encountered in Choctawhatchee Bay during nocturnal commercial fishing (D. Fox. Delaware State Univ., pers. com.).

Amendment Three of the Florida Constitution, known as the net ban, was approved by voter referendum in November 1994 and implemented in July 1995. The amendment was implemented in July 1995 and made unlawful the use of entangling nets (i.e., gill and trammel nets) in Florida waters. Other forms of nets (i.e., seines, cast nets, and trawls) were restricted, but not totally eliminated. For example, these types of nets could be used only if the total area of net mesh did not exceed 500 square feet. Implementation of the net ban has likely benefited sturgeon as they are residents of near-shore waters during much of their life span.

Florida's net ban has likely benefited or accelerated Gulf sturgeon recovery. Gulf sturgeon commonly occupy estuarine and coastal habitats where entangling gear was commonly used. Capture of small Gulf sturgeon in mullet gill nets was documented by state fisheries biologists in the Suwannee River fishery in the early 1970s. Large mesh gill nets and runaround gill nets were the fisheries gear of choice in historic Gulf sturgeon commercial fisheries. Absence of this gear in Florida eliminates it as a potential source of mortality of Gulf sturgeon.

Although a number of steps have been taken to reduce the potential for Gulf sturgeon to be incidentally caught by anglers or commercial operations, existing regulatory mechanisms are inadequate to prevent take of adult Gulf sturgeon due to fishing bycatch. Because the loss of a few reproducing adults directly affects population size and growth, inadequately regulated bycatch continues to be a threat.

4.4.15.13 ***Collisions with Boats***

Collisions between jumping Gulf sturgeon and fast-moving boats on the Suwannee River and elsewhere are a relatively recent and new source of sturgeon mortality and pose a serious public safety issue as well. The FFWC reported that in 2006, nine people were injured by direct strikes and two were injured after swerving to avoid a jumping Gulf sturgeon while boating on the Suwannee River. Nine people were also involved in incidents with jumping sturgeon during 2007, including a fatal incident: two people were ejected from their boat while turning abruptly to avoid a jumping sturgeon and one subsequently drowned. FFWC documented three collisions in the Suwannee River in 2008, and one incident as of this writing in 2009. As a result of these incidents, FFWC now maintains a public awareness campaign about the risk to the boating public with the message “Go slow on the Suwannee.” Placards have been posted and distributed along the Suwannee River in areas where Gulf sturgeon are frequently spotted jumping and in areas of high boat traffic. Gulf sturgeon factsheets, large signs, and stickers provide life history information and warn boaters to proceed at slow speeds in the spring and summer. USFWS, USGS, and NMFS have collaborated with FFWC in the information campaign to alert boaters to the collision hazard and urging slower speeds.

The reason why sturgeon jump and expend energy is unknown; one hypothesis is that jumping is a form of group communication that serves to maintain group cohesion (Sulak et al. 2002). Edwards et al. (2007) note that sturgeon jump in marine waters as well.

Ship strikes may be an emerging threat to Gulf sturgeon; ship strikes are a documented threat to Atlantic sturgeon (ASSRT 2007). FFWC personnel pulled a live juvenile Gulf sturgeon (< 1 m TL) with a partially severed tail from the Apalachicola River immediately following the passage of a barge tow at river mile 3.5 on 29 September 2004 (E. Lovestrand, pers. comm. 2004). The individual died within an hour after being rescued.

Public outreach and education is improving to alert boaters to slow down in areas where Gulf sturgeon are known to jump. However, the number of boating trips has been and is likely to continue increasing. Combined with the potential of extended droughts in the southeast that result in lowering the water level and subsequently concentrates both sturgeon and boaters into a smaller riverine cross-section, this threat is likely to increase. Boating collisions along with the potential mortality of adult Gulf sturgeon will threaten the stability of these small populations.

4.4.15.14 ***Red Tide***

Red tide is the common name for a harmful algal bloom (HAB) of marine algae (*Karenia brevis*) that can make the ocean appear red or brown. *K. brevis* is one of the first species ever reported to have caused a HAB and is principally distributed throughout the Gulf of Mexico, with occasional red tides in the mid- and south-Atlantic United States. *K. brevis* naturally produces a brevetoxin that is absorbed directly across the gill membranes of fish or through ingestion of algal cells.

While many HAB species are nontoxic to humans or small mammals, they can have significant effects on aquatic organisms. Fish mortalities associated with *K. brevis* events are very common and widespread. The mortalities affect hundreds of species during various stages of development. Intoxication begins with binding of PbTx to specific receptor sites in fish excitable tissues (Baden and Mende 1982). Signs of intoxication in fish include violent twisting and corkscrew swimming, defecation and regurgitation, pectoral fin paralysis, caudal fin curvature, loss of equilibrium, quiescence, vasodilation, and convulsions, culminating in death due to respiratory failure. Mortality typically occurs at concentrations of 2.5 x 105 *K. brevis* cells/L, which is often considered to be a lethal concentration. However, it is known that fish can die at lower cell concentrations and can also apparently survive in much higher concentrations (at 3 million cells/L). In some instances, mortality from red tide is not acute but may occur over a period of days or weeks of exposure to subacute toxin concentrations.

Since the 1990's the blooms of red tide have been increasing in frequency; the most recent outbreak occurred in 2007 and 2008. Red tide was the probable cause of death for at least 20 Gulf sturgeon in Choctawhatchee Bay in 1999 (USFWS 2000). Dead and dying Gulf sturgeon were reported to the FWRI Fish Kill Hotline in January 2006 attributed to post-bloom exposure (http://research.myfwc.com/features). More frequent or prolonged algal blooms may result from longer growing seasons predicted with climate change (FWC 2009). Red tides will likely continue to increase in frequency. Based on the best available information, toxins associated with red tide have likely killed Gulf sturgeon at both the juvenile and adult life stages. Because the loss of a small number of reproducing adults can have a significant overall effect on the status and trend of the population red tide is a threat to the Gulf sturgeon.

4.4.15.15 *Aquaculture*

In 2001, Florida Department of Agriculture's Division of Aquaculture (Department) established requirements for sturgeon aquaculture in the State. An application and permitting procedure requires sturgeon aquaculture producers to adhere to best management practices (BMPs), as provided by Chapter 597, Florida Statutes. Aquaculture producers obtain an aquaculture certificate of registration (http://www.floridaaquaculture.com). Chapter 9 of the Statute describes BMPs for sturgeon culture acknowledging that sturgeon aquaculture is a high-risk effort that requires holding of sturgeon for five to eight years before product is available for market. The manual also states that Florida sturgeon culture is currently limited to native Atlantic sturgeon and a few nonnative species. The sturgeon BMPs were developed after the threats or risks of hybridization from aquaculture activities were assessed in a risk assessment workshop sponsored by the Department, FFWC, and Mote Marine Laboratory in April 2000. The sturgeon BMPs require site selection and facility design to prevent the escape of all life stages, reporting of imports, health and escape, and minimum standards for protecting and maintaining offsite water quality and wildlife habitat. Failure to comply with the BMPs can result in a misdemeanor of the first degree, and is subject to a suspension or revocation of certification. The Department may, in lieu of, or in addition to the suspension or revocation, impose on the violator an administrative fine in an amount not to exceed $1,000 per violation per day.

Although BMPs have been issued for Florida, and the Department monitors farms with sturgeon onsite, the risk of hybridization and escapement still occurs. The best screening of water pipes to ensure fish do not escape via irrigation systems does not guarantee that full containment, especially for fish of smaller sizes. Effects of wind and rain associated with hurricanes and unusual weather events can cause overflow of tanks, impacts to irrigation systems, and result in unintended escape of fish. The geographic location of many farms nearby streams and rivers would allow easy entry of farmed fish into sturgeon habitat. As many farms use spring-fed wells as a their source for irrigation, sturgeon raised in farms have likely acclimated to local water temperatures and would presumably survive in local rivers. While effects of intra-specific competition between native and non-natives sturgeons are unknown, it is likely that habitat overlapping would occur as well as a potential for introduction of disease. Other states within the geographic range of the Gulf sturgeon have not implemented similar licensing, monitoring or BMPs.

Therefore, while Florida has issued BMPs and monitors sturgeon farms, the threat of introduction of captive fish into the wild, and potential hybridization continues.

4.4.15.16 ***Critical Habitat***

In 2003, NMFS designated critical habitat for Gulf sturgeon. Primary constituent elements that were identified for the conservation of the Gulf sturgeon include the following:

Abundant food items, such as detritus, aquatic insects, worms, or molluscs, within riverine habitats for larval and juvenile life stages; and abundant prey items, such as amphipods, lancelets, polychaetes, gastropods, ghost shrimp, isopods, molluscs or crustaceans, within estuarine and marine habitats, and substrates for subadult and adult life stages.

Riverine spawning sites with substrates suitable for egg deposition and development, such as limestone outcrops and cut limestone banks, bedrock, large gravel or cobble beds, marl, soapstone, or hard clay.

Riverine aggregation areas, also referred to as resting, holding, and staging areas, used by adults, subadults, or juveniles, generally, but not always, located in holes below normal riverbed depths, believed necessary for minimizing energy expenditures during freshwater residency and possibly for osmoregulatory functions.

A flow regime (i.e., the magnitude, frequency, duration, seasonality, and rate-of-change of freshwater discharge over time) necessary for normal behavior, growth, and survival of all life stages in the riverine environment, including migration, breeding site selection, courtship, egg fertilization, resting, and staging, and for maintaining spawning sites in suitable condition for egg attachment, egg sheltering, resting, and larval staging.

Water quality, including temperature, salinity, pH, hardness, turbidity, oxygen content, and other chemical characteristics, necessary for normal behavior, growth, and viability of all life stages.

Sediment quality, including texture and other chemical characteristics, necessary for normal behavior, growth, and viability of all life stages.

Safe and unobstructed migratory pathways necessary for passage within and between riverine, estuarine, and marine habitats (e.g., an unobstructed river or a dammed river that still allows for passage).

Most of these primary constituent elements are not applicable to the marine portions of the AFTT Study Area. Only the Panama City OPAREA overlaps with Gulf sturgeon critical habitat (Figure 23). This critical habitat (Unit 11) encompasses Florida nearshore Gulf of Mexico waters in Escambia, Santa Rosa, Okaloosa, Walton, Bay, and Gulf counties in Florida. Unit 11 is important because it provides migration habitat for Gulf sturgeon *en route* from Gulf of Mexico winter and feeding grounds to their spring and summer natal (hatching) rivers (the Yellow, Choctawhatchee, and Apalachicola Rivers). Gulf sturgeon remain within 1 mi. (1.6 km) of the coastline between Pensacola Bay and Apalachicola Bay, in depths of less than 20 ft. (6 m) during the winter (Fox et al. 2000a; Fox et al. 2002; U.S. Fish and Wildlife Service 2009).

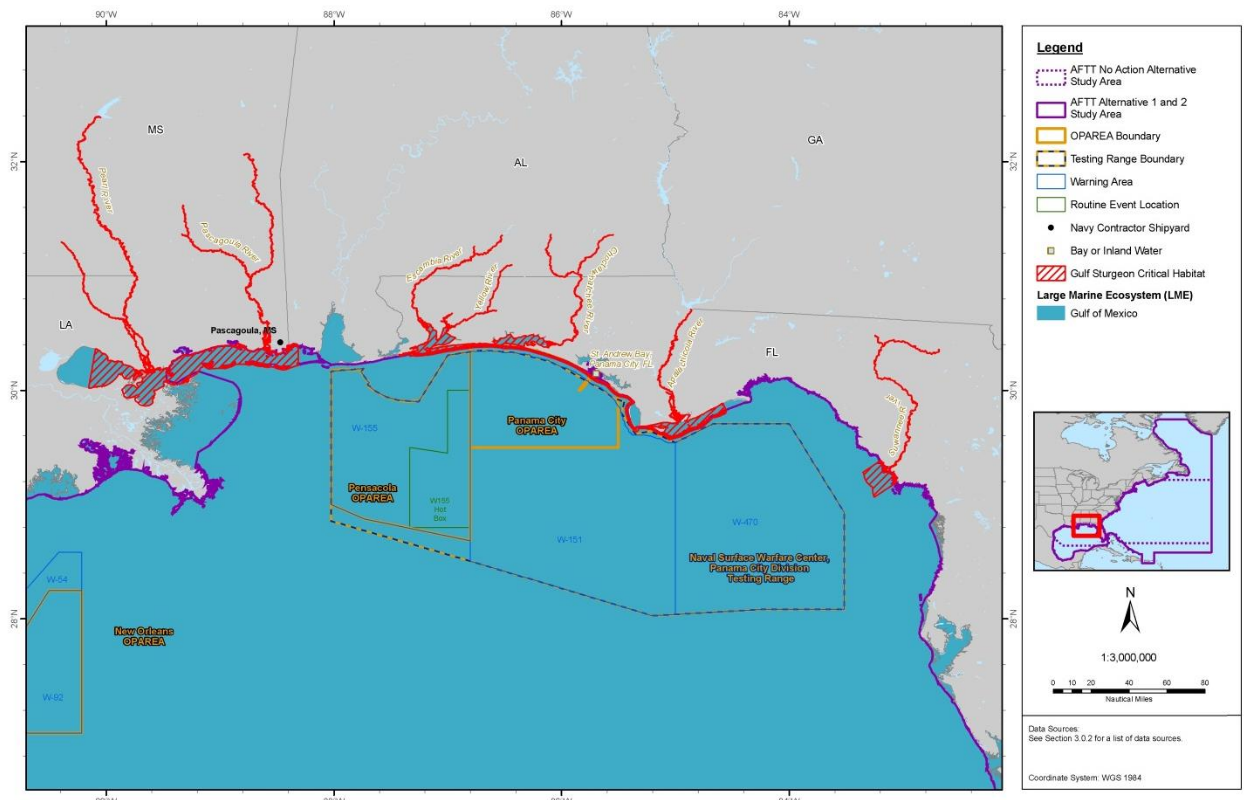

Figure 23. Gulf Sturgeon Critical Habitat in Relation to US Navy Range Complexes

5 ENVIRONMENTAL BASELINE

By regulation, environmental baselines for Opinions include the past and present impacts of all state, federal, or private actions and other human activities in the action area, the anticipated impacts of all proposed federal projects in the action area that have already undergone formal or early section 7 consultation, and the impact of state or private actions that are contemporaneous with the consultation in process (50 CFR §402.02). The Environmental baseline for this Opinion includes the effects of several activities affecting the survival and recovery of proposed or listed species as well as their proposed or designated critical habitats in the action area.

The Environmental baseline for this consultation focuses on the status and trends of the aquatic ecosystems in the United States and the consequences of that status for listed resources that occur in a general region. Since our action area and the Environmental baseline encompass a very broad spatial scale with many distinct ecosystems, wherever possible we have focused on common indicators of the biological, chemical, and physical health of the nation's aquatic environments. The Environmental baseline for this consultation provides the backdrop for evaluating the effects of the action on listed and proposed resources under NMFS' jurisdiction.

We divided the Environmental baseline for this consultation into marine versus freshwater regions. The freshwater component includes estuaries as well as three broad geographic regions: the Northeast Atlantic Region, the Southeast Atlantic Region, and the Gulf Coast Region. In some instances regions were further subdivided according to ecoregions, importance to NMFS' trust resources or other natural features. In each freshwater section we described the biological and ecological characteristics of the region such as the climate, geology, and predominant vegetation to provide landscape context and highlight some of the dominant processes that influence the biological and ecological diversity of the region where proposed, threatened, and endangered species reside. We then described the predominant land and water uses within a region to illustrate how the physical and chemical health of regional waters and the impact of human activities have contributed to current status of listed and proposed resources.

Stressors within the marine environment tend to be much more ubiquitous than in freshwater ecosystems and thus we have not generally divided stressors in the marine environment into more specific components, although some areas are relatively unique in regards to some stressors, such as oil and gas industrial activities or hurricane impacts, and are described in a more regional context.

5.1 Climate Change

We primarily discuss climate change as a threat common to all species addressed in this Opinion, rather than in each of the species-specific narratives. As we better understand responses to climate change, we will address these effects in relevant species-specific sections.

In general, based on forecasts made by the Intergovernmental Panel on Climate Change (IPCC), climate change is projected to have substantial direct and indirect effects on individuals, populations, species, and the structure and function of marine, coastal, and terrestrial ecosystems in the near future (IPCC 2000; IPCC 2001a; IPCC 2001b; IPCC 2002). From 1906-2006, global surface temperatures have risen 0.74º C and continues at an accelerating pace; 11 or the 12 warmest years on record since 1850 have occurred since 1995 (Poloczanska et al. 2009).

Furthermore, the Northern Hemisphere (where a greater proportion of ESA-listed species occur) is warming faster than the Southern Hemisphere, although land temperatures are rising more rapidly than over the oceans (Poloczanska et al. 2009).

The direct effects of climate change will result in increases in atmospheric temperatures, changes in sea surface temperatures, patterns of precipitation, and sea level. Oceanographic models project a weakening of the thermohaline circulation resulting in a reduction of heat transport into high latitudes of Europe, an increase in the mass of the Antarctic ice sheet, and a decrease in the Greenland ice sheet, although the magnitude of these changes remain unknown. Species that are shorter-lived, of larger body size, or generalist in nature are liable to be better able to adapt to climate change over the long term versus those that are longer-lived, smaller-sized, or rely upon specialized habitats (Brashares 2003; Cardillo 2003; Cardillo et al. 2005; Issac 2009; Purvis et al. 2000). Climate change is most likely to have its most pronounced effects on species whose populations are already in tenuous positions (Isaac 2008). As such, we expect the risk of extinction to listed species to rise with the degree of climate shift associated with global warming.

Twilley et al. (2001) used two climate scenarios with each predicting warmer temperatures (3° F to 7° F throughout the Gulf of Mexico in summer and 2.8° C in the eastern Gulf of Mexico and as much as 5.6° F in the western Gulf of Mexico in the winter). Along the northeastern U.S., temperature has increased by 2° C since 1970 and is predicted to increase by another 1.4 to 2.2° C in winter and 0.8 to 1.9° C in summer (Karl et al. 2009). Temperatures in the southeastern U.S. have increased by 1.1° C since 1970. Although global climate change models have predicted an increase in sea-level of 20 to 51 cm along the Gulf Coast over the next 100 years, regional characteristics including the Gulf's flat topography, regional land subsidence, extensive shoreline development, and vulnerability to major storms suggests a more dramatic sea-level increase of 38 cm along most of the Gulf Coast to as much as 112 cm along the Louisiana/Mississippi Delta (Twilley et al. 2001).

Changes in air and sea surface temperatures affect the marine environment in several ways. Variations in sea surface temperature can affect an ecological community's composition and structure, alter migration and breeding patterns of fauna and flora and change the frequency and intensity of extreme weather events. Over the long term, increases in sea surface temperature also can reduce the amount of nutrients supplied to surface waters from the deep sea leading to declines in fish populations (EPA 2010b), and, therefore, declines in those species whose diets are dominated by fish.

Some indirect effects of climate change would result from changes in the distribution of temperatures suitable for whale calving and rearing, the distribution and abundance of prey and abundance of competitors or predators. For species that undergo long migrations, individual movements are usually associated with prey availability or habitat suitability. If either is disrupted, the timing of migration can change or negatively impact population sustainability (Simmonds and Eliott. 2009). Climatic variability is thought to possibly result in populations of cetaceans relocating from areas they currently use in response to changes in oceanic conditions (MacLeod et al. 2005). Climate change can influence reproductive success by altering prey availability, as evidenced by low-success of northern elephant seals during El Niño periods, when cooler, more productive waters are associated with higher first year pup survival (McMahon and Burton. 2005). Reduced prey availability resulting from increased sea surface temperatures has also been suggested to explain reductions in Antarctic fur seal pup and harbor porpoise survival (Forcada et al. 2005; Macleod et al. 2007). Polygamous marine mammal mating systems can also be perturbated by rainfall levels, with the most competitive grey seal males being more successful in wetter years than in drier ones (Twiss et al. 2007). For marine mammals considered in this Opinion, available data suggest sperm whale females have lower rates of conception following periods of unusually warm sea surface temperature (Whitehead 1997). Marine mammals with restricted distributions linked to water temperature may be particularly exposed to range restriction (Issac 2009; Learmonth et al. 2006). MacLeod (2009) estimated that, based upon expected shifts in water temperature, 88% of cetaceans would be affected by climate change, 47% would be negatively affected, and 21% would be put at risk of extinction. Of greatest concern are cetaceans with ranges limited to non-tropical waters and preferences for shelf habitats (Macleod 2009). Variations in the recruitment of krill and the reproductive success of krill predators correlate to variations in sea-surface temperatures and the extent of sea-ice coverage during winter months. Although the IPCC (2001b) did not detect significant changes in the extent of Antarctic sea-ice using satellite measurements, Curran et al. (2003) analyzed ice-core samples from 1841-1995 and concluded Antarctic sea ice cover had declined by about 20% since the 1950s.

Roughly 50% of the Earth's marine mammal biomass occurs in the Southern Ocean, with all baleen whales feeding largely on a single krill species, Euphausia superba, here and feeding virtually nowhere else (Boyd 2002). Atkinson et al. (2004) linked sea ice loss to severe decreases in krill populations over the past several decades in some areas of the Antarctic. Reid and Croxall (2001) analyzed a 23-year time series of the reproductive performance of predators (Antarctic fur seals, gentoo penguins, macaroni penguins, and black-browed albatrosses) that depend on krill for prey and concluded that these populations experienced increases in the 1980s followed by significant declines in the 1990s; overall an increase in the frequency of years with reduced reproductive success occurred. These declines resulted, at least in part, from changes in the structure of the krill population, particularly reduced recruitment into older krill age classes, which lowered the number of predators krill could sustain. The authors concluded that the biomass of krill within the largest size class was sufficient to support predator demand in the 1980s but not in the 1990s. By 2055, severe reductions in fisheries catch due to climate change have been suggested to occur in the Indo-Pacific, Red Sea, Mediterranean Sea, Antarctic, and tropical areas worldwide while increased catches are expected in the Arctic, North Pacific, North Atlantic, and northern portions of the Southern Ocean (Cheung et al. 2010).

Climate change has been linked to changing ocean currents as well. Rising carbon dioxide levels have been identified as a reason for a poleward shift in the Eastern Australian Current, shifting warm waters into the Tasman Sea and altering biotic features of the area (Poloczanska et al. 2009). Similarly, the Kuroshio Current in the western North Pacific (an important foraging area for juvenile sea turtles) has shifted southward as a result of altered long-term wind patterns over the Pacific Ocean (Poloczanska et al. 2009).

Climate-mediated changes in the distribution and abundance of keystone prey species like krill and climate-mediated changes in the distribution of cephalopod populations worldwide is likely to affect marine mammal populations as they re-distribute throughout the world's oceans in search of prey. If sea ice extent decreases, then larval krill may not be able to survive without access to underice algae to feed on. This may be a cause of decreased krill abundance in the northern western Antarctic Peninsula during the last decade (Fraser and Hofmann 2003). Meltwaters have also reduced surface water salinities, shifting primary production along the Antarctic Peninsula (Moline et al. 2004). Blue whales, as predators that specialize in eating krill, are likely to change their distribution in response to changes in the distribution of krill (Clapham et al. 1999; Payne et al. 1986; Payne et al. 1990c). If they did not change their distribution or could not find the biomass of krill necessary to sustain their population numbers, their populations (and other large whales with similar life histories, such as humpback whales) would likely experience declines similar to those observed in other krill predators, including dramatic declines in population size and increased year-to year variation in population size and demographics. These outcomes would dramatically increase the extinction probability of baleen whales. Edwards et al. (2007) found a 70% decrease in one zooplankton species in the North Sea and an overall reduction in plankton biomass as warm-water species invade formerly cold-water areas. Productivity may increase in other areas, though, providing more resources for local species (Brown et al. 2009). In addition, reductions in sea ice may alleviate "choke points" that allow some marine mammals to exploit additional habitats (Higdon and Ferguson 2009).

The indirect effects of climate change would result from changes in the distribution of temperatures suitable for reproduction, the distribution and abundance of prey and abundance of competitors or predators. For species that undergo long migrations, individual movements are usually associated with prey availability or habitat suitability. If either is disrupted by changing ocean temperature regimes, the timing of migration can change or negatively impact population sustainability (Simmonds and Eliott. 2009). For sea turtles, warming ocean temperatures may extend poleward the habitat which they can utilize (Poloczanska et al. 2009). Seagrass habitats have declined by 29% in the last 130 years and 19% of coral reefs have been lost due to human degradation, reducing lower latitude habitat for some sea turtle species (Poloczanska et al. 2009). Primary production is estimated to have declined by 6% between the early 1980s and 2010, making foraging more difficult for marine species (Hoegh-Guldberg and Bruno 2010).

Foraging is not the only potential aspect that climate change could influence. Acevedo-Whitehouse and Duffus (2009) proposed that the rapidity of environmental changes, such as those resulting from global warming, can harm immunocompetence and reproductive parameters in wildlife to the detriment of population viability and persistence. Pike et al. (2006) concluded that warming sea surface temperatures may lead to potential fitness consequences in sea turtles resulting from altered seasonality and duration of nesting. Sea turtles will also be affected by loss of historic nesting habitat by elevated sea levels and skewed sex ratios as warming temperatures may lead to the production of female only clutches (Newson et al. 2009). Genetic analyses and behavioral data suggest that populations with temperature-dependent sex determination may be unable to evolve rapidly enough to counteract the negative fitness consequences of rapid global temperature change (Hays 2008 as cited in Newson et al. 2009). However, Hayes et al. (2010) suggests that because of the increased frequency of male loggerhead breeding (based on visits to breeding sites) versus female breeding, the ability of males to breed with many females and the ability of females to store sperm and fertilize many clutches, any skewed sex ratios due to climate change can be compensated for and population effects may be ameliorated. Sea turtles may expand their range as temperature-dependent distribution limits change (McMahon and Hays 2006). An example of this is the altered sex ratios observed in sea turtle populations worldwide (Fuentes et al. 2009a; Mazaris et al. 2008; Reina et al. 2008; Robinson et al. 2008). This does not yet appear to have affected population viabilities through reduced reproductive success, although average nesting and emergence dates have changed over the past several decades by days to weeks in some locations (Poloczanska et al. 2009). However, such a fundamental shift in population demographics causes a fundamental instability in population viability. Altered ranges can also result in the spread of novel diseases to new areas via shifts in host ranges (Simmonds and Eliott. 2009). It has also been suggested that increases in harmful algal blooms could be a result from increases in sea surface temperature (Simmonds and Eliott. 2009).

Changes in global climatic patterns will likely have profound effects on the coastlines of every continent by increasing sea levels and the intensity, if not the frequency, of hurricanes and tropical storms (Wilkinson and Souter 2008). A half degree Celsius increase in temperatures during hurricane season from 1965 to 2005 correlated with a 40% increase in cyclone activity in the Atlantic. Sea levels have risen an average of 1.7 mm/year over the 20th century and 3.3 mm/year between 1993 and 2006 due to glacial melting and thermal expansion of ocean water; this rate will likely increase, which is supported by the latest data from 2009 (Arndt et al. 2010; Hoegh-Guldberg and Bruno 2010; Wilkinson and Souter 2008). Based on computer models, these phenomena would inundate nesting beaches of sea turtles, change patterns of coastal erosion and sand accretion that are necessary to maintain those beaches, and would increase the number of turtle nests destroyed by tropical storms and hurricanes (Wilkinson and Souter 2008), although other areas might experience less frequent tropical activity and a subsequent reduction in tropical cyclone impacts to sea turtle nests (Fuentes and Abbs 2010). The loss of nesting beaches, by itself, would have catastrophic effects on sea turtle populations globally if they are unable to colonize new beaches that form or if the beaches do not provide the habitat attributes (sand depth, temperatures regimes, and refuge) necessary for egg survival. In some areas, increases in sea level alone may be sufficient to inundate sea turtle nests and reduce hatching success (Caut et al. 2009a). Storms may also cause direct harm to sea turtles, causing “mass” strandings and mortality (Poloczanska et al. 2009). Increasing temperatures in sea turtle nests alters sex ratios, reduces incubation times (producing smaller hatchlings), and reduces nesting success due to exceeded thermal tolerances (Fuentes et al. 2009b; Fuentes et al. 2010; Fuentes et al. 2009c). Smaller individuals likely experience increased predation (Fuentes et al. 2009b). Taken together, the body of literature on climate change supports widespread and significant negative consequences to sea turtle species.

Climatic shifts also occur due to natural phenomenon. In the North Atlantic, this primarily concerns fluctuations in the North Atlantic Oscillation (NAO), which results from changes in atmospheric pressure between a semi-permanent high pressure feature over the Azores and a subpolar low pressure area over Iceland (Curry and McCartney 2001; Hurrell 1995; Stenseth et al. 2002). This interaction affects sea surface temperatures, wind patterns, and oceanic circulation in the North Atlantic (Stenseth et al. 2002). The NAO shifts between positive and negative phases, with a positive phase having persisted since 1970 (Hurrell 1995). North Atlantic conditions experienced during positive NAO phases include warmer than average winter weather in central and eastern North America and Europe and colder than average temperatures Greenland and the Mediterranean Sea (Visbeck 2002). Effects are most pronounced during winter (Taylor et al. 1998). The NAO is significant for North Atlantic right whales due to its influence on the species primary prey, zooplankton of the genus Calanus, which are more abundant in the Gulf of Maine during positive NAO years (Conversi et al. 2001; Drinkwater et al. 2003; Greene and Pershing 2004; Greene et al. 2003a; Kiszka et al. 2010). This subsequently impacts the nutritional state of North Atlantic right whales and the rate at which sexually mature females can produce calves (Greene et al. 2003a). Local distribution shifts of North Atlantic right whales may be tied to the NAO (Kenney 2007).

The potential for invasive species to spread under the influence of climatic change is also a significant concern. If water temperatures warm in marine ecosystems, native species may shift poleward to cooler habitats, opening ecological niches that can be occupied by invasive species introduced via ships ballast water or other sources (Philippart et al. 2011; Ruiz et al. 1999). A similar observation of "Caribbean creep" has been observed, with warmer waters facilitating the range expansion of warmer-water species into more northerly regions (Canning-Clode et al. 2011). Although these expansions may be temporary, they can include harmful algal bloom species whose presence even temporarily can cause major morbidity and mortality issues to a variety of endemic species (Hallegraeff 2010). Moore et al. (2011) estimated that the impacts of a dinoflagellate establishment would likely intensify with a warming climate, resulting in roughly 13 more days of potential bloom conditions per year by the end of the 21st century. Invasive species that are better adapted to warmer water temperatures can also outcompete native species that are physiologically geared towards lower water temperatures; such a situation currently occurs along central and northern California, where the Mediterranean blue mussel has established and is displacing a native mussel competitor (Lockwood and Somero 2011).

5.2 Freshwater and Coastal Estuarine Systems

5.2.1 Maine to Massachusetts

This region encompasses Maine, New Hampshire, and Massachusetts. The region is ecologically diverse, encompassing several broad ecoregions—according to Bailey's (1995) Description of the Ecoregions of the United States this region encompasses the warm continental, the hot continental and the hot continental mountains divisions —these ecoregions can be further subdivided into provinces based on vegetation (Bailey 1995). This region encompasses the New England/Acadian mixed forests and the Northeastern Coastal Forests.

In this section, we describe several basins and estuarine complexes to characterize past and current human activities and their impacts on the area.

5.2.1.1 *Land Use*

Most of the watersheds within this region are heavily forested with relatively small areas of highly urbanized lands. Land use in the Penobscot watershed is 5% agriculture and 95% forest and wetland (90% forest and forested wetlands). There are approximately 21 people per square mile living in the Penobscot watershed, and the largest town is Bangor, consisting of 33,000 people (Jackson et al. 2005). While there is not much urban development in the watershed, Doggett and Sowles (1989) report tanneries, metal finishing, pulp and paper mills, textile plants, chemical products, and municipal sewage contribute chromium, mercury, zinc, copper, lead, arsenic, hydrocarbons, dioxins, PAHs, pesticides, and other contaminants to the river.

The Kennebec River watershed usage is 82% forest, 10% water, 6% agriculture, 2% developed (Jackson et al. 2005). The only major town in the watershed is Augusta, Maine, but there are approximately 39 people per square mile throughout the watershed (Jackson et al. 2005). Currently, the primary pollution source on the river is from two pulp and paper mills, but there were multiple historical polluters along the river. The river exceeds recommended levels of dioxins, arsenic, cadmium chromium, copper, lead, mercury, nickel, silver, zinc, and PAHs in the sediments and surface water (MDEP 1999) (Harding Lawson Associates 1999; Harding Lawson Associates 2000). Since 1990, the levels of dioxins in other rivers in Maine have been decreasing, but the levels in the Kennebec have remained constant (Kahl 2001).

The Androscoggin River watershed usage is 5% agriculture, 86% forested, 7% water, and 2% developed (Jackson et al. 2005). Major towns in the Androscoggin watershed are Auburn, Lewiston, and Brunswick. The human population in the watershed is approximately 65 people per square mile (Jackson et al. 2005). Throughout the 20th century, textile mills, paper and pulp mills, and municipalities contributed large quantities of pollutants to the river. At one time it was considered one of the 10 most polluted rivers in the country and was one of the reasons for the implementation of the Clean Water Act. The river has become much cleaner since the Clean Water Act (CWA) was passed, but pesticides, mercury, lead, sedimentation, total suspended solids, PCBs, and dioxins are still considered too high (Chamberland et al. 2002).

The Merrimack River watershed is composed of 75% forest, 13% urban, 6% agriculture, 5% surface water, and 1% other (Jackson et al. 2005). The Merrimack River flows through industrial centers Manchester and Concord, New Hampshire, and Lowell and Lawrence, Massachusetts. There are approximately 404 people per square mile in the Merrimack watershed (Jackson et al. 2005). The biggest sources of pollution facing the river are combined sewage overflows, industrial discharge, urbanization and its associated run-off (USACE 2003). The upper mainstem of the river has problems with bacteria, E. coli, and acidity, while the lower mainstem has problems with bacteria, metals, nutrients, dioxins, turbidity and suspended solids, and un-ionized ammonia. In all, over 125 miles of mostly lower watershed areas do not support their designated uses (USACE 2003).

5.2.1.2 ***Hydromodification Projects***

There are five major hydroelectric dams along the mainstem of the Penobscot River as well as 111 other licensed dams located along the river and its tributaries. Atlantic salmon historically migrated as far as 143 miles upstream of the mouth, but due to development along the river, in the 1960s, Atlantic salmon were extirpated (Jackson et al. 2005). The population has since been re-established and runs of 2,000 to 4,000 occur with natural spawning as far upstream as 62 miles. Unfortunately, 6,000 to 10,000 salmon are required for a sustainable population, so the Penobscot run depends on fish from a local hatchery (Moore and Platt 1997).

The Kennebec River has eight large hydroelectric dams on its mainstem, which restricts fish passage both up and downstream. In 1999, the Edwards Dam was removed, opening 17 additional miles of habitat for fish and macroinvertebrates in the river. Removal of Edwards dam restored full access to historical spawning habitat for species like Atlantic sturgeon, shortnose sturgeon, and rainbow smelt, but not for species like alewife, American shad, and Atlantic salmon that migrated much further up the river. Since the removal of Edwards Dam, DO levels and macroinvertebrate density have improved. Additionally, in 2007, the fish passage facilities on the lowest dam on the Kennebec River as well as the second and third lowest dams on the Sebasticook River became operational. The lowest dam on the Sebasticook River has been decommissioned and may be breached in as early as 2007 (MDMR 2007).

The Androscoggin River has 14 hydroelectric dams on the mainstem of the river and 18 in the watershed. Fish ladders have been installed on the lower dams allowing anadromous fish passage to Lewiston Falls (Brown et al. 2006). The dams play a considerable role in the poor water quality of the river, causing reduced DO throughout the summer. During the 60s, most of the river had oxygen levels of 0ppm, resulting in massive fish kills. There is still a 14 mile stretch of river that requires aerators to provide dissolved oxygen to the river.

The Merrimack River watershed has over 500 dams, including three in Massachusetts and three in New Hampshire, that essentially make the mainstem into a series of ponds (Dunn Jr 2002; Jackson et al. 2005). Flow alteration is considered a problem on the upper mainstem of the river and has resulted in the river not meeting EPA's flow requirements (USACE 2003).

5.2.1.3 *Mining*

Mining in Northeast Atlantic watersheds first began prior to the Civil War. Since then, mining has been conducted for granite, peat, roofing slate, iron ore, sulfur, magnetite, manganese, copper, zinc, mica, and other materials. Currently, exploration for precious metals and basic metals is ongoing, but to a lesser extant than during the 1980s. Recent mining activities were conducted in this region by The Penobscot Nation, Champion Paper Company, Oquossoc Minerals, Boliden Resources, Inc., Black Hawk Mining, and BHP-Utah. There are several abandoned mines in the Northeast Atlantic coast watersheds that have become superfund sites due to excessive pollutants being leached into groundwater, such as Elizabeth Mine, Pike Hill Mine, Calhoun Mines, and others. Common pollutants leaked by mining operations in this area are lead, mercury, arsenic, and selenium (Ayuso et al. 2006; Piatak et al. 2006). All mines that are not in use are supposed to be decommissioned and cleaned up, but the impacts could persist for years before the rivers return to their pristine state.

5.2.2 Connecticut to Virginia

This region consists of Connecticut, Rhode Island, New York, New Jersey, Delaware, Pennsylvania, Maryland and Virginia.

5.2.2.1 *Connecticut River/Long Island Sound*

5.2.2.2 *Land Use*

More than eight million people live in the Long Island Sound watershed. With so many people in the watershed, both point and non-point source pollution is a major concern. Toxic substances often adsorb to the surface of sediments, which means sediments with high surface to volume ratios like sand, silt, and clay, can hold more pollutants than larger substrates. The sound has elevated levels of PCBs, PAHs, nitrogen, lead, mercury, cadmium, cesium, zinc, copper, and arsenic. Organic and metal contaminants in Long Island Sound are above national averages (Turgeon and O'Connor 1991). Lead, copper, and zinc are believed to be deposited via the atmosphere (Cochran et al. 1998). Cadmium, chlordane, and lead appear to be decreasing while copper is increasing (Turgeon and O'Connor 1991). Studies on winter flounder showed PAHs and PCBs leading to alteration of DNA in the livers of those fish (Gronlund et al. 1991). One of the biggest problems facing the sound is DO depletion (Parker and O'Reilly 1991), resulting in dead zones. The governors of Connecticut and New York have signed agreements to reduce the total nitrogen input to Long Island Sound by 58.5% before 2015 in an effort to get the DO of surface water above 5ppm, of deeper water above 3.5ppm, and no water ever below 2ppm.

Within the Connecticut River watershed the dominant land use is forest (80%), with 11% used for agriculture and the remaining 9% in mixed (other) uses (Jackson et al. 2005). Major towns in the Connecticut watershed are Holyoke and Springfield, Massachusetts and Hartford, Connecticut. The human population in the watershed is approximately 179 people per square mile (Jackson et al. 2005). Throughout the 20th century, power plants, defense contractors, municipalities, and corporations such as General Electric, Union Carbide, and Pfizer contributed large quantities of pollutants to the river. Still to this day, approximately one billion gallons of raw sewage enters the river as a result of combined sewer overflow from Hartford, Connecticut alone (CRWC 2006). The river has become much cleaner since the CWA was passed, but chromium, copper, nickel, lead, mercury, and zinc, chlordane, DDT, DDE, PCBs, and PAHs are found in quantities above the EPA recommended levels in sediments and fish tissue throughout the watershed (Jackson et al. 2005). Acid rain also affects rivers in the northeast, as it reduces the pH of rivers and causes metals to leach from bedrock at a faster rate (Usfws 2007).

5.2.2.3 ***Hydromodification Projects***

The Connecticut River has 16 hydroelectric dams on the mainstem of the river and as many as 900 are estimated to have been built in the watershed. Fish ladders have been installed at Vernon, Turner Falls, and Holyoke Dams allowing fish passage to areas above Holyoke Dam in Massachusetts since 1981 (Usgs 2004). For some species, the ladders are not efficient, so fish passage continues to be compromised. For instance, overall passage efficiency at Turner Falls fish ladder is 17%, and has historically been inefficient at passing shad. Shortnose sturgeon are not able to migrate to spawning habitat above Holyoke Dam, which was recently re-licensed through 2039, so the only spawning shortnose sturgeon in the river are the fish that reside above the dam. The dams also affect the river's water quality, causing reduced DO and elevated water temperatures throughout the summer.

5.2.2.4 ***Mining***

Dating back thousands of years, there is evidence of native people mining and extracting natural resources from the headwaters of the Connecticut River. There are many mines along the Connecticut River, which currently degrade the river's water quality, including the country's first chartered copper mine. Towns such as Plymouth, Vermont were famous for mining gold, iron, talc, soapstone, marble, asbestos, and granite (Ewald 2003). Other towns through New

Hampshire and Vermont also mined gold, silver, soapstone, talc, granite, slate, and copper (Ewald 2003). In many locations, far downstream of the mines, accumulated heavy metals are in concentrations high enough to threaten aquatic life. In other cases, the mines are abandoned or failing and need to be cleaned. Such is the case with Elizabeth Mine, an old copper mine perched above the Connecticut River that leaches heavy metals into the river. As a result, Elizabeth Mine has been declared a superfund site. There is little to no mining in Long Island Sound and the concept is generally frowned upon in the region, although there has been and continues to be discussions about mining for sand and gravel.

5.2.2.5 ***Hudson River Basin***

5.2.2.6 ***Land Use***

The Hudson River watershed usage is 25% agriculture, 65% forested, 8% urban, and 5% other (Jackson et al. 2005). Major towns in the Hudson River watershed are New York City, Albany, Poughkeepsie, and Hudson, New York and Jersey City, New Jersey. The human population in the watershed is approximately 350 people per square mile, but there are no people living in the headwaters and the population density in Manhattan is over 25,907 people per square mile (Jackson et al. 2005).

Throughout the 20th century, power plants, municipalities, pulp and paper mills, and corporations such as IBM, General Motors, and General Electric in particular, who the EPA estimates dumped between 209,000 and 1.3 million pounds of PCBs into the river, contributed large quantities of pollutants to the Hudson. The PCB levels in the Hudson River are amongst the highest nationwide. The upper basin is mostly unaffected by humans, with clear, soft water with low nutrients. The middle Hudson is more polluted, with 30 to 50% of the land in this region being used for agriculture and several cities such as Corinth, Glens Falls, Hudson Falls, and Fort Edward contributing industrial waste to the river. The tidal freshwater portion of the Hudson is nutrient rich with exceptionally low gradient. High tide in this stretch causes the river to flow backwards due to the low gradient and this prevents stratification. The brackish tidal estuary portion of the Hudson is nutrient rich with hard water. Two hundred miles of the Hudson River, from Hudson Falls to New York City, were designated as a superfund site due to the amount of pollution. There are still elevated amounts of cadmium, copper, nickel, chromium, lead, mercury, and zinc, DDT, PCBs, and PAHs are found in quantities above the EPA recommended levels in sediments and fish tissue throughout the watershed (Wall et al. 1998).

5.2.2.7 ***Hydromodification Projects***

The mainstem Hudson River has 14 dams and there are dams near the mouths of many tributaries, but the lower 154 miles of tidally influenced river is undammed. Several flood control dams on tributaries such as the Indian and Sacandaga Rivers have drastically altered the flow of the mainstem Hudson River. The Hudson is an important river for anadromous fishes because it is unobstructed for the lower 154 miles, resulting in the healthiest population of ESA-listed endangered shortnose sturgeon in the United States. Prior to the Clean Water Act, the middle stretch of the Hudson and much of the lower reaches had low dissolved oxygen as a result of reduced flow behind the dams, high nutrients, and the collection of waste with high biological oxygen demand.

5.2.2.8 *Mining*

The Hudson River has been periodically important as a source of metals and mined resources. The Adirondack Mountains, in the headwaters, have mined silver, iron, titanium, coal, talc, vanadium, graphite, garnet, and zinc at various times over the past 300 years. McIntyre Mine is an example of a mine that has produced different minerals during different generations. Initially bought as an iron mine, McIntyre sat dormant for 75 years before titanium was discovered there, at which point National Lead purchased it and mined there until 1982 when NL Industries abandoned the mine.

5.2.2.9 *Delaware River Basin*

5.2.2.10 *Land Use*

The Delaware River watershed usage is 24% agriculture, 60% forested, 9% urban, and 7% surface water or other (Jackson et al. 2005). Major towns in the Delaware River watershed are Easton, Allentown, Reading, and Philadelphia, Pennsylvania; Trenton and Camden, New Jersey; and Wilmington, Delaware. The human population in the watershed is approximately 555 people per square mile (Jackson et al. 2005). The water quality was significantly degraded around Philadelphia by 1799. By the 1960s the average DO in the lower river was approximately 0.2ppm. A survey in the 1970s of organochlorine frequency in rivers ranked the Delaware at Trenton and the Schuylkill, the largest tributary to the Delaware, as the 8th and 1st worst, respectively in the nation (Jackson et al. 2005). While there are not many point sources of pollution since the Clean Water Act was enacted, historically, power plants, municipalities, pulp and paper mills, and industries such as the Philadelphia Shipyard, Bethlehem Steel, New Jersey Zinc Company, contributed large quantities of pollutants to the Hudson. Approximately 95% of PCBs are introduced to the river through combined sewage overflows from treatment plants. Even 35 years after the Clean Water Act, there are still elevated amounts of copper, chromium, lead, mercury, and zinc, DDT, PCBs, and PAHs are found in quantities above the EPA recommended levels in sediments and fish tissue throughout the watershed (Wall et al. 1998). The heaviest concentrations of chemicals in the river occur in a 14 mile stretch between the Philadelphia naval yard and the Tacony-Palmyra Bridge.

5.2.2.11 *Hydromodification Projects*

The Delaware River has 16 dams in the headwaters but the middle and lower river is the longest undammed stretch of river east of the Mississippi. This stretch of free-flowing river is beneficial to anadromous and catadromous species, such as American shad, striped bass, and American eels.

5.2.2.12 *Mining*

The Delaware River watershed, particularly the eastern section was home to the majority of the nation’s anthracite coal. As a result, many mining towns were established in the watershed to exploit the abundant resources. By 1914, over 181,000 people were employed as miners in the region. Apart from the coal mining, other minerals such as sulfur, talc, mica, aluminum, titanium, and magnesium were mined. Mines were also established for sand and gravel. Eventually minerals from the watershed were used to produce steel.

5.2.2.13 *Chesapeake Bay Drainages*

5.2.2.14 *Land Use*

The Susquehanna River watershed usage is 20% agriculture, 63% forested, 9% urban, and 7% pasture (Jackson et al. 2005). Major towns in the Susquehanna River watershed are Scranton, State College, and Harrisburg, Pennsylvania and Havre de Grace, Maryland. The human population in the watershed is approximately 145 people per square mile (Jackson et al. 2005). The water quality has not been well documented because the river wasn't used as a primary source of drinking water for any major cities. The three main events that had the greatest effect on the river were logging, dam building, and mining. While most of these activities took place in the 1800s, the river is still responding to the disruption they caused (Jackson et al. 2005). Sediment transport in the early 1900s was nine times higher than it was 200 years earlier, due to logging and agriculture. Sediment transport and its associated nutrients remain a major concern for the Chesapeake Bay. Coal is abundant through the watershed, amounting to nearly 30 billion tons of coal mined. Coal waste and acid mine drainage damaged much of the river and its tributaries. There was so much coal silt in the Susquehanna at one point that a fleet of over 200 vessels began harvesting the silt from the river's bed. From 1920 to 1950, over 3 million tons of coal were harvested from behind one dam. Later, between 1951 and 1973, over 10 million tons were harvested from behind another dam. Coal is no longer a primary industry in the watershed, but the impacts of the acid mine drainage are still prominent. Another major problem is untreated sewage and industrial waste that is dumped directly into the river. In Binghampton, New York, there are 10 sewer outfalls, 70 in Scranton, Pennsylvania, 65 in Harrisburg, Pennsylvania, and the number of outfalls totals over 400 in the watershed, generally with the number of outfalls being proportional to the size of the city. As a result, the Susquehanna contributes 44% of the nitrogen and 21% of the phosphorous to the Chesapeake Bay. This has led to large algal blooms in the bay and a resulting "dead zone" between Annapolis, Maryland and Newport News, Virginia. In 2005, the Susquehanna was named America's most endangered river by American Rivers, who produce an annual list. Even 35 years after the Clean Water Act, there are still elevated amounts of copper, sulfur, selenium, arsenic, cobalt, chromium, lead, mercury, zinc, and pesticides (Beyer and Day 2004).

The Potomac River watershed usage is 32% agriculture, 58% forested, 5% developed, 4% water, 1% wetland, and 1% barren (Jackson et al. 2005). Major towns in the Potomac River watershed are Washington, D.C.; Arlington and Alexandria, Virginia; and Hagerstown, Maryland. The human population in the watershed is approximately 358 people per square mile (Jackson et al. 2005). The water quality has significantly improved over the past 50 years. Even 35 years after the Clean Water Act, there are still elevated amounts of cadmium, chromium, copper, lead, dioxin, PCBs, and chlordane, which may have resulted in recent highly publicized reports of male fish producing eggs.

The James River watershed usage is 23% agriculture, 71% forested, and 6% urban (VDCR 2006). Major towns in the James River watershed are Charlottesville, Richmond, Petersburg, and Hampton Roads, Virginia. The human population in the watershed is approximately 2.5 million people, or approximately 240 people per square mile (VDCR 2006). The James River has 21 municipal dischargers permitted and 28 permitted industrial dischargers. There are also 18 EPA Superfund sites along the river, mostly found in the major cities along its corridor. In some cases, industries such as Allied Chemical were fined and forced to clean up large areas of extreme toxicity. Even 35 years after the Clean Water Act, there are still elevated amounts of zinc, copper, cadmium, nickel, chromium, lead, arsenic, dioxin, PCBs, and pesticides.

5.2.2.15 *Hydromodification Projects*

There are many dams along the Potomac River and its tributaries, but only three impoundments are larger than 1.5 square miles. One of the major tributaries, the Anacostia River, is having over 60 dams removed or altered to improve water quality and fish passage.

The Susquehanna River has over 100 dams along the mainstem and the first major dam is located just 10 miles upstream of the mouth. In recent years modern fishways have been installed in some of these dams and migratory fish appear to be responding positively. For instance, between 1928 and 1972, no shad passed Conowingo Dam, 10 miles upstream of the mouth of the Susquehanna River, but since fish began coming back, their abundance has increased from approximately 100 to more than 100,000.

The James River has several large dams along its length. Many dams have been removed or improved to allow fish passage, and in 1999, a ladder was built over Boscher Dam, which had prevented upstream fish runs since 1823. That ladder provided access to 137 additional miles of the James and 168 miles of its tributaries.

5.2.2.16 *Mining*

In the Chesapeake Bay watershed, coal mining has likely had the most significant impact on water quality. Mining in this watershed was so extensive that while many mines have been reclaimed and others are currently being reclaimed, at the current level of funding, it will take decades or more to completely reclaim all of the old mines in the watershed. Abandoned coal mines leach sulfuric acid as a result of natural reactions with the chemicals found in coal mines. Many of these abandoned coal mines must be treated with doses of limestone to balance the pH of the water draining from the mines. Much of the Appalachian Mountain chain that was mined for coal is now leaching sulfuric acid into tributaries of the Chesapeake Bay and requires some sort of treatment to improve the water quality of the region.

5.2.3 North Carolina to Florida

This region covers all the drainages that ultimately drain to the Atlantic Ocean between the states of North Carolina and Florida. This region includes all of South Carolina and parts of Georgia, North Carolina, Florida, and Virginia. The region encompasses three ecoregions—the hot continental division, subtropical division, and savanna division (southern-most tip of Florida's panhandle).

5.2.3.1 *Albemarle-Pamlico Sound Complex*

5.2.3.2 *Land Use*

Land use in the Roanoke River is dominated by forest (68%) and the basin contains some of the largest intact, least disturbed bottomland forest floodplains along the eastern coast. Only 3% of the basin qualifies as urban land uses, and 25% is used for agriculture (Smock and Benke 2005). The only major town in the Roanoke watershed is Roanoke, Virginia. The population in the watershed is approximately 80 people per square mile (Smock and Benke 2005). In contrast, the Neuse River watershed is described as 35% agriculture, 34% forested, 20% wetlands, and 5% urban, and 6% other, with a basin wide density of approximately 186 people per square mile (Smock and Benke 2005). While the population increased in the Albemarle-Pamlico Complex more than 70% during the last 40 years, the rate of growth is relatively low for many coastal counties in the Southeast (EPA 2006b). Much of the estuarine complex is protected by large amounts of state and federally protected lands, which may reduce development pressures.

Throughout the 20th century, mining, agriculture, paper and pulp mills, and municipalities contributed large quantities of pollutants to the Roanoke River and the Albemarle-Pamlico Estuarine Complex. Even so, today the Albemarle-Pamlico Estuarine Complex is rated in good to fair condition in the National Estuary Program Coastal Condition Report despite that over the past 40-year period data indicate some noticeable changes in the estuary, including increased dissolved oxygen levels, increased pH, decreased levels of suspended solids, and increased chlorophyll a levels (EPA 2006b).

Coal is mined from the mountainous headwaters of the Roanoke River in southwestern Virginia. Mining through the piedmont and coastal areas of North Carolina was conducted for limestone, lead, zinc, titanium, apatite, phosphate, crushed stone, sand, and fossils. Many active mines in these watersheds are still in operation today. These mines are blamed for increased erosion, reduced pH, and leached heavy metals.

Agricultural activities are major source of nutrients to the estuary and a contributor to the harmful algal blooms (HABs) in summer, although according to McMahon and Woodside 1997 (EPA 2006a) nearly one-third of the total nitrogen inputs and one-fourth of the total phosphorus input to the estuary are from atmospheric sources. Primary agricultural activities within the watershed include corn, soybean, cotton, peanut, tobacco, grain, potato, and the production of chicken, hog, turkey, and cattle.

In general, the Roanoke River is much cleaner since the passage of the CWA, although mercury, arsenic, cadmium, chromium, copper, lead, nickel, zinc, and PCBs are still considered high (NCDENR 1999). Fish tissues sampled within the estuary also showed elevated concentrations of total PAHs and total PCBs—10% of the sampled stations exceeded risk-based EPA Advisory Guidance values (EPA 2006b). Water quality studies in the mid-1990s showed the Neuse Basin contained the highest nitrogen and phosphorus yields, while the Chowan Basin had the lowest yields (Spruill and Survey 1998).

The Neuse River entered the national spotlight during the early 1990s due to massive and frequent fish kills within the basin. Over one billion American shad have died in the Neuse River since 1991. The problem is persistent but the cause of the kills differs among events; in 2004 more than 700,000 estuarine fish died and more than 5,000 freshwater fish died within the basin. Freshwater species most commonly identified during investigations included sunfishes, shad, and carp, while estuarine species most commonly reported included menhaden, perch, and croaker. Atlantic menhaden have historically been involved in a majority of estuarine kill events and have exhibited stress and disease in conjunction with fish kills. Fish kill events may often have different causative agents, and in many cases the precise cause is not clear, but high levels of nutrients, HABs, toxic spills, outbreaks of a marine organism, Pfiesteria pescicida, low DO concentrations and sudden wind changes that mix hypoxic waters, are some of contributing factors or causes to the basins persistent fish kills (NCDEQ 2004).

Both the Roanoke River and the Neuse Rivers are fragmented by dams. The reservoirs are used for flood control and recreation, but the amount of agricultural and urban runoff that collects behind the dams has caused sanitation problems in the recent past. Three dams were removed recently in an effort to improve environmental conditions and fish passage. Widespread stream modification and bank erosion were rated high within the greater watershed relative to other sites in the Nation (Spruill and Survey 1998).

5.2.3.3 *Major Southeast Coastal Plains Basins*

5.2.3.4 *Land Use*

Across this region, land use is dominated by agriculture and industry, and to a lesser extent timber and paper production, although more than half of most basins remain forested. Basin population density is highly variable throughout the region with the greatest density in the St. Johns River watershed with about 200 people per square mile of catchment, most of whom are located near Jacksonville, Florida. In contrast, there are only 29 people per square mile in the Saltilla River watershed in Georgia (Smock and Benke 2005). See Table 38 for a summary of land uses and population densities in several area basins across the region (data from (Smock and Benke 2005).

Table 38. Land uses and population density in several southeast Atlantic basins (Smock and Benke 2005).

Watershed	Land use categories (%)				Density (people/mi.2)
	Agriculture	Forested	Urban	Other	
Cape Fear River	24	56	9	11	80
The Great Pee-Dee	28	58	8	6	127
Santee-Cooper River	26	64	6	4	168
Savannah River	22	65	4	9	91
Ogeechee River	18	54	1	17 (wetlands)	78
Altamaha River	--	64	3	7	73
Satilla River	26	72	1	1	29
St. Johns River	25	45	6	24 (wetlands & water)	202

The largest population centers in the region include Miami and Jacksonville, Florida, and Savannah, Georgia. Major towns include Greensboro, Chapel Hill, Fayetteville, South Carolina, and Wilmington, North Carolina in the Cape Fear River watershed; Winston-Salem, North Carolina and Georgetown, Florence, and Sumter, South Carolina in the Great Pee-Dee River Watershed; Charlotte, Hickory, and Gastonia, North Carolina and Greenville and Columbia, South Carolina in the Santee-Cooper River watershed; Savannah and Augusta, Georgia, in the Savannah River watershed; Louisville, Statesboro, and Savannah, Georgia, in the Ogeechee River watershed; Athens, and Atlanta, Georgia, in the Altamaha River watershed; and Jacksonville, Florida in the St. Johns River watershed.

Several of the rivers in the region have elevated levels of metals including mercury, fecal coliform, bacteria, ammonia, turbidity, and low DO. These impairments are caused by municipal sewage overflows, mining, and non-point source pollution, waterfowl, urban runoff, marinas, agriculture, and industries including textile manufacturing, power plant operations, paper mills and chemical plants (Berndt et al. 1998; Harned and Meyer 1983; NCDWQ 1998; Smock and Benke 2005).

Several watersheds exhibit high nitrogen loads including the Cape Fear River, Winyah Bay, Charleston Harbor, St. Helena Sound, Savannah River, Ossabaw Sound, Altamaha River, and St. Mary's River and Cumberland Sound (Bricker et al. 2007). Nitrate concentrations (as nitrogen) tend to be higher in stream draining basins with agricultural and mixed land uses (Berndt et al. 1998). Based on studies in Georgia, however, nitrate loads did not vary with growing season of crops (periods of heaviest fertilizer application), but were influenced by high streamflow, which could be related to downstream transport by subsurface flows (Berndt et al. 1998).

Sediment is the most serious pollutant in the Yadkin (Pee-Dee) River and has historically been blamed on agricultural runoff. In the mid-1990s, farmers in the region began using soil conservation techniques that have reduced sediment inputs by 77%. Unfortunately, the reduction in sediment inputs from farms did not translate to a reduction in sediment in the river, as during this period there was a 25% reduction in agricultural land and a 38% increase in urban development.

5.2.3.5 *Mining*

Mining occurs throughout the region. South Carolina is ranked 25th in the states in terms of mineral value and 13th among the eastern 26 states, and produces 1% of the total nonfuel mineral production value in the United States. There are currently 13 minerals being extracted from 485 active mines in South Carolina alone. Portland and masonry cement and crushed stone were the State's leading nonfuel minerals in 2004 (NMA 2007). In contrast, Georgia accounts for 4%, Florida accounts for 5%, and North Carolina accounts for 1.76% of the total nonfuel mineral production value in the United States. North Carolina's leading nonfuel minerals in 2004 were crushed stone, phosphate rock, and construction sand and gravel. Georgia produces 24% of the clay in the nation; other leading nonfuel minerals include crushed stone and Portland cement. Florida is the top phosphate rock mining state in the United States and produces about six times more than any other state in the nation. Peat and zirconium concentrates are also produced in Florida.

The first gold mine discovered and operated in the United States is outside Charlotte, North Carolina in the Pee Dee watershed. Mines through Georgia are also major producers of barite and crude mica, iron oxide, and feldspar. There is a proposed titanium mine near the mouth of the Satilla River. Unfortunately, mines release some toxic materials and negatively impact fish, as fish living around dredge tailings have elevated levels of mercury and selenium.

5.2.3.6 *Hydromodification Projects*

Several of the rivers within the area have been modified by dams and impoundments. In contrast to rivers along the Pacific Coast, we found considerable less information on other types of hydromodification projects in this area, such as levees and channelization projects. There are three locks and dams along the mainstem Cape Fear River and a large impoundment on the Haw River. The lower river and its tributaries are relatively undisturbed. The lower reach is naturally a blackwater river with naturally low dissolved oxygen, which is compounded by the reduced flow and stratification caused by upstream reservoirs and dams. The Yadkin (Pee Dee) River is heavily utilized for hydroelectric power. There are many dams on Santee-Cooper River System. The Santee River Dam forms Lake Marion and diverts the Santee River to the Cooper River, where another dam, St. Stephen Dam, regulates the outflow of the Santee River. Lake Moultrie is formed by both St. Stephen Dam and Pinopolis Dam, which regulates the flow of the Cooper River to the ocean. Below the fall line, the Savannah River is free-flowing with a meandering course, but above the fall line, there are three large dams that turn the piedmont section of the river into a 100-mile long stretch of reservoir. Although the Altamaha River is undammed, hydropower dams are located in its tributaries the Oconee and Ocmulgee Rivers above the fall lines. There are no dams, however, along the entire mainstem Satilla River. There are no major dams on the mainstem St. Johns River either, but one of the largest tributaries has a dam on it. The St. Johns River’s flow is altered, however, by water diversions for drinking water and agriculture.

5.2.4 **Florida to Texas**

This region encompasses states of Alabama, Arkansas, Illinois, Iowa, Kansas, Kentucky, Louisiana, Mississippi, Missouri, Oklahoma, South Dakota, Tennessee, the western portion of Florida including the Florida Keys, and parts of, Georgia, Texas, Minnesota, Montana, North Dakota, Nebraska, Colorado, Indiana, Ohio, New Mexico, North Carolina, Pennsylvania, Virginia, West Virginia, Wisconsin, Wyoming, Mexico, and two Canadian provinces. Almost 2/3 of the continental United States drains to the Gulf of Mexico through the Mississippi River Basin.

5.2.4.1 ***Land Use***

Land use is dominated by forest in the basins east of the Mississippi, whereas grass/shrub and rangeland uses dominate in basins west of the Mississippi. The Mississippi also appears to be a divide between the less developed eastern basins, and the increasingly urbanized western basins. According to data presented in Table 39, the most developed watersheds are the Trinity River, the San Antonio and Guadalupe Rivers, the Brazos River, the Colorado River, and the Mississippi River. Most of the population within the San Antonio River watershed is concentrated within the greater San Antonio area. Based on data from 2000, the population density of San Antonio is an estimated 1,122 people/mi2, and in other areas of the basin density is as little as 16 people/mi2 (Dahm et al. 2005). The Trinity River Basin encompasses several urban areas including one of the most highly populated areas in the region--the City of Dallas. In stark contrast, overall there are only 29 people per square mile in the Neches River watershed (Dahm et al. 2005).

Table 39. Land uses and population density in several Gulf of Mexico basins (Brown et al. 2005; Dahm et al. 2005; Ward and Ward 2005).

Watershed	Land use categories (%)				Density (people/mi. 2)
	Agriculture	Forested	Urban	Other	

Watershed	Land use categories (%)				Density (people/mi. 2)
	Agriculture	Forested	Urban	Other	
Suwannee River	30	38	1	9	57
Apalachicola River System	25	55	2	18 (10% wetland)	133
Choctawhatchee River	25	57	1	17 (9% wetland)	46
Escambia-Conecuh River	15	72	<1	12 (7% wetland)	86
Mobile River	18	68	2	12 (7% wetlands)	114
Pascagoula River	17	66	1	16 (11% wetland)	75
Pearl River	24	58	2	15 (12% wetland)	109
Mississippi River	57	28	14	---	26
Sabine River	10	67	8	15 grassland	47
Neches River	15	65	5	15 grassland	29
Trinity River	15	35	30	20 grassland	254
Brazos River	24	3	16	15 grassland	52
Colorado River	30	--	15	55 range	91
San Antonio and Guadalupe Rivers	15	--	25	60 range	220
Nueces River	15	--	5	55 shrubland	42
Rio Grande River	5	14	7	74 shrub & grass	42

Major threats to the southwestern basins also include wastewater effluent, water extraction, non-point source pollution, nonnative species, existing impoundments, and proposals for dams (Dahm et al. 2005), and new reservoirs are proposed for some basins (Lane-Miller and DeVries 2007). Municipal waste water discharge poses a serious problem in several rivers, including the Suwannee River basin, and the Chattahoochee and Flint Rivers. According to Dahm et al. (2005) the Rio Grande is one of the most impacted rivers due to water quality and quantity concerns. The basin suffers from elevated levels of salinity, nutrients, bacteria, metals, pesticides, herbicides, organic solvents, and the basin is heavily hydromodified by dams and water diversions for irrigation. About 100 miles downstream of Atlanta the Chatahoochee is very polluted, with excessive amounts of nutrients, pesticide, fecal coliform bacteria, PAHs, and oils. The lower Mississippi River is degraded by excess fecal coliform bacteria, PCBs, chlordane, turbidity, siltation, nutrients, reduced DO, pesticides, and eutrophication. Most of the riparian habitat has been lost to agriculture and urban development (Brown et al. 2005).

In many basins agricultural practices associated with row crops (corn, soybeans, hay and cotton) confined animal feeding operations (poultry and lifestock—hog, cattle, sheep, goats), and dairy production are significant source of nutrients, fecal coliform, and pesticides. Other basins are severely impacted by altered sediment regimes. The Choctawhatchee River watershed has highly erodable soils, heavy rains, and intermittent droughts that leads to excessive sediment loading. Erosion causes sediment and nutrient issues, while droughts cause low flow and low dissolved oxygen. In contrast, downcutting of reaches of the Brazos River are a problem resulting from numerous dams interrupting sediment transport within the basin.

Several rivers including the Pascagoula River and its tributaries, and the Sabine River are also impaired by sediment, pathogens, low DO, fecal coliform, nutrients, mercury, PCB, dioxin, ammonia, pesticides like atrazine, and BOD. Occasional fish kills occur within the Colorado River as a result of storm runoff and low DO. The upper Colorado River has salinity problems and many reservoirs have problems with toxic golden algae (Dahm et al. 2005). The upper Brazos River basin has naturally high salinity, the middle basin has elevated nutrients from nearby dairy farms, several reservoirs have toxic golden algae, and the lower basin has elevated atrazine, bacteria, phosphorous, and low DO (Dahm et al. 2005). Major polluters in the Mobile River include pulp and paper mills, textiles, chemical plants, hydroelectric, iron and steel manufacturing, and coal plants.

Pollution of this nature can reduce productivity and health of the fish populations within the basin, and at times can lead to fish kills. Since 1998, there have been at least 16 fish kills, at least one of which was the result of elevated ammonia levels, two were contributed to pesticides, 10 were from low DO, and 3 were from unknown causes (MSDEQ 2000). Large fish kills are the most severe and usually the most easily observed response of aquatic ecosystems to pollution, but often the degradation is more elusive occurring at sublethal levels.

5.2.4.2 ***Mining***

Mining occurs throughout the region. Mining along the eastern Gulf of Mexico coast is primarily for clay, sand, limestone, phosphate, and peat. There are also some sulfide mines upstream on the Apalachicola River and gravel mines in the Escambia River.

5.2.4.3 ***Hydromodification Projects***

Several of the rivers within the area have been modified by dams, impoundments for navigation, levees, and drainage systems. Some rivers on both the eastern and western portion of the Gulf (including the Mississippi River) have been heavily hydromodified—fragmented by hydroelectric power plants and navigational dams, channels have been deepened, straightened, and contained within levees. For instance, there are 13 dams on the mainstem Chattahoochee and three on the Flint River, but there are no major dams on the Apalachicola River. There are 36 major dams in the Mobile River watershed, and the Trinity River watershed is also highly fragmented with 21 major dams throughout the watershed.

There are more than 132 dams on the Brazos River—as a result of the dams there has been a reduction in sediment transport to reaches below the dams, consequently the river channel has deepened (downcut) resulting in the isolation of the mainstem from several of the oxbow lakes and off channel habitat once available to the native fishes and other animals. According to Dahm et al. (2005), although development is not prevalent in the lower river due to the frequency of flooding, the river is threatened by existing and proposed diversions to the neighboring cities of Houston and Fort Worth. Additionally, dredging activities have been documented to capture or kill 168 sea turtles from 1995 to 2009 in the Gulf of Mexico, including 97 loggerheads, 35 Kemp's ridleys, 32 greens, and three unidentified sea turtles (USACOE 2010).

5.2.5 Hurricanes

The Gulf of Mexico, Caribbean Sea, and southern US Atlantic seaboard is prone to major tropical weather systems, including tropical storms and hurricanes. The impacts of these storms on sea turtles in the marine environment is not known, but storms can cause major impacts to sea turtle eggs on land, as nesting frequently overlaps with hurricane season, particularly Kemp's ridley sea turtles (NRC 1990c). Climate change is expected to affect the intensity of hurricanes through increasing sea surface temperatures, a key factor that influences hurricane formation and behavior (EPA 2010b). The intensity of tropical storms in the Atlantic Ocean, Caribbean, and Gulf of Mexico has risen noticeably over the past 20 years and six of the 10 most active hurricane seasons have occurred since the mid-1990s (EPA 2010b). Mortality can result both from drowning of individuals while still in the egg or emerging from the nest as well as causing major topographic alteration to beaches, preventing hatchling entry to marine waters. Kemp's ridley sea turtles are likely highly sensitive to hurricane impacts, as their only nesting locations are in a limited geographic area along southern Texas and northern Mexico (Milton et al. 1994a). In 2010, Hurricane Alex made landfall in this area; surprisingly, few nests were lost (Jaime Pena, Gladys Porter Zoo, pers. comm.). Tropical storm Hermine arrived too late in 2010 to impact eggs or hatchlings at Rancho Nuevo (Donna Shaver, NPS, pers. comm.). However, Ross (2005) reported that in one study adult fecundity, nesting periodicity, and nest site location were not changed and adult mortality was negligible following a hurricane in the Indian Ocean. The effects of recent hurricanes in the Gulf of Mexico on sea turtle population numbers and trends are not yet known although Milton et al. (Milton et al. 1994b) reported high levels of sea turtles killed and nests lost due to Hurricane Andrew in 1992.

5.2.6 Habitat Degradation

A number of factors may be directly or indirectly affecting listed species in the action area by degrading habitat. One of the most significant is noise. Natural sources of ambient noise include: wind, waves, surf noise, precipitation, thunder, and biological noise from marine mammals, fishes, and crustaceans. Anthropogenic sources of ambient noise include: transportation and shipping traffic, dredging, construction activities, geophysical surveys, and sonars. In general, it has been asserted that ocean background noise levels have doubled every decade for the last six decades in some areas, primarily due to shipping traffic (IWC 2004b). The acoustic noise that commercial traffic contributes to the marine environment is a concern for listed species because it may impair communication between individuals (Hatch et al. 2008).

Vessel noise could affect marine animals in the action area. Shipping and seismic noise generally dominates ambient noise at frequencies from 20 to 300 Hz (Andrew et al. 2002; Hildebrand 2009; Richardson et al. 1995d). Background noise has increased significantly in the past 50 years as a result of increasing vessel traffic, and particularly shipping, with increases of as much as 12 dB in low frequency ranges and 20 dB versus preindustrial periods (Hildebrand 2009; Jasny et al. 2005; McDonald et al. 2006; NRC 1994; NRC 2003; NRC 2005b; Richardson et al. 1995d). Over the past 50 years, the number of commercial vessels has tripled, carrying an estimated six times as much cargo (requiring larger, more powerful, and consequently louder vessels) (Hildebrand 2009). Seismic signals also contribute significantly to the low frequency ambient sound field (Hildebrand 2009). Baleen whales may be more sensitive to sound at those low frequencies than are toothed whales. Dunlop et al. (2010) found that humpback whales shifted from using vocal communication (which carries relatively large amounts of information) to surface-active communication (splashes; carry relatively little information) when low-frequency background noise increased due to increased sea state. Sonars and small vessels also contribute significantly to mid-frequency ranges (Hildebrand 2009). Many researchers have described behavioral responses of marine mammals to the sounds produced by helicopters and fixed-wing aircraft, boats and ships, as well as dredging, construction, geological explorations, etc. (Richardson et al. 1995e). Most observations have been limited to short term behavioral responses, which included cessation of feeding, resting, or social interactions. Several studies have demonstrated short-term effects of disturbance on humpback whale behavior (Baker et al. 1983; Bauer and Herman 1986b; Hall 1982; Krieger and Wing 1984), but the long-term effects, if any, are unclear or not detectable.

The northeastern US hosts some of the busiest commercial shipping lanes in the world, including those leading into Boston, Providence, Newark, and New York (MARAD 2011). Container ship calls to U.S. Atlantic ports are expected to increase 4 percent per year through 2020, and vessel calls to U.S. Atlantic coast ports are forecast to rise from approximately 47,200 calls in 2000 to 93,500 calls in 2020 (Ward-Geiger et al. 2005). Four of the U.S.' busiest ports are also located in the GOM; handling about 45% of U.S. shipped tonnage (Würsig et al. 2000b). Tanker traffic in the northern Gulf is most intense between the Mississippi and Sabine Rivers; in 1998, there were 40,599 tanker in this region (Minerals Management Service 2000). Ship strikes are potential sources of serious injury or mortality to large whales. In addition to vessel traffic, marine construction activities occur in the Cape Cod area (liquefied natural gas terminal construction, pile driving, offshore wind farm construction, dredging, cable laying, drilling, and others) that contributes to local and regional background sound levels.

In-water construction activities (e.g., pile driving associated with shoreline projects) in both inland waters as well as coastal waters in the action area can produce sound levels sufficient to disturb proposed and listed species under some conditions. Pressure levels from 190-220 dB re 1 μPa were reported for piles of different sizes in a number of studies (NMFS 2006a). The majority of the sound energy associated with pile driving is in the low frequency range (<1,000 Hz) (Illingworth and Rodkin Inc. 2001; Illingworth and Rodkin Inc. 2004; Reyff 2003). Dredging operations also have the potential to emit sounds at levels that could disturb individuals of many taxa. Depending on the type of dredge, peak sound pressure levels from 100 to 140 dB re 1 μPa were reported in one study (Clarke et al. 2003). As with pile driving, most of the sound energy associated with dredging is in the low-frequency range, <1000 Hz (Clarke et al. 2003). Three large, in-water construction projects are known to be underway or underdevelopment that have the potential to impact North Atlantic right whales. A 130-turbine wind farm is proposed or reviewed for construction off Long Island, New York and another in Massachusetts Bay. Both projects would involve pile driving that produces large amounts of sound in the frequency range used by North Atlantic right whales. As this sound would likely persist for extended periods, there is the potential for North Atlantic right whales to abandon local areas in favor of areas where they can better used their primary mechanism for gaining information about their environment. Although neither area co-occurs locally with high North Atlantic right whale use, individuals do forage in waters near the Massachusetts site and may migrate past the New York site to and/or from their southeastern/northeastern US breeding and foraging areas. In addition, a liquefied natural gas terminal is planned for construction off Gloucester, Massachusetts. This project would involve similar stressors, but located in prime North Atlantic right whale foraging habitat.

Several measures have been adopted to reduce the sound pressure levels associated with in-water construction activities or prevent exposure of marine mammals to sound. For example, a six-inch block of wood placed between the pile and the impact hammer used in combination with a bubble curtain can reduce sound pressure levels by about 20 dB (NMFS 2008c). Alternatively, pile driving with vibratory hammers produces peak pressures that are about 17 dB lower than those generated by impact hammers (Nedwell and Edwards 2002). Other measures used in the action area to reduce the risk of disturbance from these activities include avoidance of in-water construction activities during times of year when marine mammals may be present; monitoring for marine mammals and sea turtles during construction activities; and maintenance of a buffer zone around the project area, within which sound-producing activities would be halted when marine mammals enter the zone (NMFS 2008c).

Marine debris is another significant concern for listed species and their habitats. Marine debris has been discovered to be accumulating in gyres throughout the oceans. Law et al. (2010) presented a time series of plastic content at the surface of the western North Atlantic Ocean and Caribbean Sea from 1986 to 2008. More than 60% of 6,136 surface plankton net tows collected small, buoyant plastic pieces. The data identified an accumulation zone east of Bermuda that is similar in size to the accumulation zone in the Pacific Ocean.

Ingestion of marine debris can have fatal consequences even for large whales as well as sea turtles. In 1989, a stranded sperm whale along the Mediterranean was found to have died from ingesting plastic that blocked its' digestive tract (Viale et al. 1992). A sperm whale examined in Iceland had a lethal disease thought to have been caused by the complete obstruction of the gut with plastic marine debris (Lambertsen 1990). The stomach contents of two sperm whales that stranded separately in California included extensive amounts of discarded fishing netting (NMFS 2009). A fifth individual from the Pacific was found to contain nylon netting in its stomach when it washed ashore in 2004(NMFS 2009). Further incidents may occur but remain undocumented when carcasses do not strand.

For sea turtles, marine debris is a problem due primarily to individuals ingesting debris and blocking the digestive tract, causing death or serious injury (Laist et al. 1999; Lutcavage et al. 1997a). Gulko and Eckert (2003) estimated that between one-third and one-half of all sea turtles ingest plastic at some point in their lives; this figure is supported by data from Lazar and Gracan (Lazar and Gračan 2010), who found 35% of loggerheads had plastic in their gut. One study found 37% of dead leatherback turtles had ingested various types of plastic (Mrosovsky et al. 2009). A Brazilian study found that 60% of stranded green sea turtles had ingested marine debris (primarily plastic and oil; (Bugoni et al. 2001)). Loggerhead sea turtles had a lesser frequency of marine debris ingestion. Plastic is possibly ingested out of curiosity or due to confusion with prey items; for example, plastic bags can resemble jellyfish (Milton and Lutz 2003). Marine debris consumption has been shown to depress growth rates in post-hatchling loggerhead sea turtles, elongating the time required to reach sexual maturity and increasing predation risk (McCauley and Bjorndal 1999). Studies of shore cleanups have found that marine debris washing up along the northern Gulf of Mexico shoreline amounts to about 100 kg/km (ACC 2010; LADEQ 2010; MASGC 2010; TGLO 2010). Sea turtles can also become entangled and die in marine debris, such as discarded nets and monofilament line (Laist et al. 1999; Lutcavage et al. 1997a; NRC 1990c; O'Hara et al. 1988). This fundamentally reduces the reproductive potential of affected populations, many of which are already declining (such as loggerhead and leatherback sea turtle populations in the action area).

5.2.7 **Dredging**

Marine dredging vessels are common within U.S. coastal waters. Although the underwater noises from dredge vessels are typically continuous in duration (for periods of days or weeks at a time) and strongest at low frequencies, they are not believed to have any long-term effect on sea turtles. However, the construction and maintenance of federal navigation channels and dredging in sand mining sites have been identified as sources of sea turtle mortality. Hopper dredges in the dredging mode are capable of moving relatively quickly compared to sea turtle swimming speed and can thus overtake, entrain, and kill sea turtles as the suction draghead(s) of the advancing dredge overtakes the resting or swimming turtle. Entrained sea turtles rarely survive.

5.2.8 **Oil and Gas Development**

The Gulf of Mexico is an epicenter for marine oil and gas development and extraction within the action area. The major sources of industrial underwater noise appear to be offshore oil, gas or mineral exploration and exploitation. These activities increase vessel traffic, produce loud sounds for seismic profiling, place structures in areas used by whales, and introduce noises from drilling and production into the environment (NMFS 1999; NMFS 2006e). Malme et al. (1985) exposed feeding humpback whales in southeastern Alaska to noise from a single air gun or to playback of recorded sounds of oil drilling, production platforms and aircraft. Whales showed no overall pattern of avoidance during 13 experiments, each of which included between 10 and 40 different animals. Whales startled as soon as the airgun was turned on in three experiments. These startle responses, which occurred at received sound levels between 150 to 169 dB (re 1 mPa), were thought to be caused more by the novelty of the air gun sound than by its intensity.

The northern Gulf of Mexico is the location of massive industrial activity associated with oil and gas extraction and processing. Over 4,000 oil and gas structures are located outside of state waters in the northern Gulf of Mexico; 90% of these occur off Louisiana and Texas (USN 2009). This is both detrimental and beneficial for sea turtles. These structures appreciably increase the amount of hard substrate in the marine environment, providing shelter and foraging opportunities for species like loggerhead sea turtles (Parker et al. 1983; Stanley and Wilson 2003). However, the Bureau of Ocean Energy Management requires that structures must be removed within one year of lease termination. Many of these structures are removed by explosively severing the underwater supportive elements, which produces a shock wave that kills, injures, or disrupts marine life in the blast radius (Gitschlag et al. 1997). For sea turtles, this means death or serious injury for individuals within a few hundred meters of the structure and overt behavioral (potentially physiological) impacts for individuals further out (Duronslet et al. 1986; Klima et al. 1988b). Although observers and procedures are in place to mitigate impacts to sea turtles (i.e., not blasting when sea turtles are present), not all sea turtles are observed all the time and low-level sea turtle injury and mortality still occurs (Gitschlag and Herczeg 1994; Gitschlag et al. 1997); two loggerheads were killed in August 2010 (G. Gitschlag, NOAA, pers. comm., 2012). Current annual authorized takes due to Bureau of Ocean Energy Management OCS oil and gas exploration, development, production, and abandonment activities are 30 sea turtles, including no more than one each of Kemp's ridley, green, or hawksbill turtles and no more than ten loggerhead turtles (NMFS 1988). These levels were far surpassed by the Deepwater Horizon incident (see oil spills and releases below). Overall, these activities provide both positive and negative effects at the individual level and have no clear impact at the population and species levels.

Oil pollution has been a significant concern in the Gulf of Mexico for several decades due to the large amount of extraction and refining activity in the region. Routine discharges into the northern Gulf of Mexico (not including oil spills) include roughly 88,200 barrels of petroleum per year from municipal and industrial wastewater treatment plants and roughly 19,250 barrels from produced water discharged overboard during oil and gas operations (MMS 2007b; USN 2008). These sources amount to over 100,000 barrels of petroleum discharged into the northern Gulf of Mexico annually. Although this is only 10% of the amount discharged in a major oil spill, such as the Exxon Valdez spill (roughly 1 million barrels), this represents a significant, continual, and “unseen” threat to Gulf of Mexico wildlife and habitats. Generally, accidental oil spills may amount to less than 24,000 barrels of oil discharged annually in the northern Gulf of Mexico, making non-spilled oil normally one of the leading sources of oil discharge into the Gulf of Mexico, incidents such as the 2010 Deepwater Horizon incident are exceptional (MMS 2007a). The other major source from year to year is oil naturally seeping into the northern Gulf of Mexico. Although exact figures are unknown, natural seepage is estimated at between 120,000 and 980,000 barrels of oil annually (MacDonald et al. 1993; MMS 2007b).

Although non-spilled oil is the primary contributor to oil introduced into the Gulf of Mexico, concern over accidental oil spills is well-founded. Over five million barrels of oil and one million barrels of refined petroleum products are transported in the northern Gulf of Mexico daily (MMS 2007b); worldwide, it is estimated that 900,000 barrels of oil are released into the environment as a result of oil and gas activities (Epstein and (Eds.). 2002). Even if a small fraction of the annual oil and gas extraction is released into the marine environment, major, concentrated releases can result in significant environmental impacts. Due to the density of oil extraction, transport, and refining facilities in the Houston/Galveston and Mississippi Delta areas (and the extensive activities taking place at these facilities), these locations have the greatest probability of experiencing oil spills. Oil released into the marine environment contains aromatic organic chemicals known to be toxic to a variety of marine life; these chemicals tend to dissolve into the air to a greater or lesser extent, depending upon oil type and composition (Yender et al. 2002). Solubility of toxic components is generally low, but does vary and can be relatively high (0.5-167 parts per billion; (Yender et al. 2002)). Use of dispersants can increase oil dispersion, raising the levels of toxic constituents in the water column, but speeding chemical degradation overall (Yender et al. 2002). The remaining oil becomes tar, which forms floating balls that can be transported thousands of kilometers into the North Atlantic. The most toxic chemicals associated with oil can enter marine food chains and bioaccumulate in invertebrates such as crabs and shrimp to a small degree (prey of some sea turtles (Law and Hellou 1999;

Marsh et al. 1992)), but generally do not bioaccumulate or biomagnify in finfish (Baussant et al. 2001; Meador et al. 1995; Varanasi et al. 1989; Yender et al. 2002). The loss of invertebrate communities due to oiling or oil toxicity would also decrease prey availability for hawksbill, Kemp's ridley, and loggerhead sea turtles (NOAA 2003). Furthermore, Kemp's ridley and loggerhead sea turtles, which commonly forage on crustaceans and mollusks, may ingest large amounts of oil due to oil adhering to the shells of these prey and the tendency for these organisms to bioaccumulate toxins found in oil (NOAA 2003). It is suspected that oil adversely impacted the symbiotic bacteria in the gut of herbivorous marine iguanas when the Galapagos Islands experienced an oil spill, contributing to a >60% decline in local populations the following year. The potential exists for green sea turtles to experience similar impacts, as they also harbor symbiotic bacteria to aid in their digestion of plant material (NOAA 2003). Seagrass beds may be particularly susceptible to oiling as oil contacts grass blades and sticks to them, hampering photosynthesis and gas exchange (Wolfe et al. 1988). If spill cleanup is attempted, mechanical damage to seagrass can result in further injury and long-term scarring. Loss of seagrass due to oiling would be important to green sea turtles, as this is a significant component of their diets (NOAA 2003). Sea turtles are known to ingest and attempt to ingest tar balls, which can block their digestive systems, impairing foraging or digestion and potentially causing death (NOAA 2003). Dispersants reduce the formation of tar balls. Although the effects of dispersant chemicals on sea turtles is unknown, testing on other organisms have found currently used dispersants to be less toxic than those used in the past (NOAA 2003). It is possible that dispersants can interfere with surfactants in the lungs (surfactants prevent the small spaces in the lungs from adhering together due to surface tension, facilitating large surface areas for gas exchange), as well as interfere with digestion, excretion, and salt gland function (NOAA 2003). Oil exposure can also cause acute damage upon direct exposure to oil, including skin, eye, and respiratory irritation, reduced respiration, burns to mucous membranes such as the mouth and eyes, diarrhea, gastrointestinal ulcers and bleeding, poor digestion, anemia, reduced immune response, damage to kidneys or liver, cessation of salt gland function, reproductive failure, and death (NOAA 2003; NOAA 2010b; Vargo et al. 1986a; Vargo et al. 1986c; Vargo et al. 1986b). Nearshore spills or large offshore spills can oil beaches on which sea turtles lay their eggs, causing birth defects or mortality in the nests (NOAA 2003; NOAA 2010b).

Geraci (1990) found no conclusive evidence that oil contamination has led to sperm whale mortality, and no adverse effects recorded with any certainty. Some observations indicate possible modification of swimming speed and direction or reduced surface time in oiled waters, but no obvious ill effects were noted (Geraci 1990).

Several oil spills have impacted the northern Gulf of Mexico over the past few years, largely due to hurricanes. The impacts of Hurricane Ivan in 2004 on the Gulf Coast included pipeline damage causing 16,000 barrels of oil to be released and roughly 4,500 barrels of petroleum products from other sources (BOEMRE 2010; USN 2008). The next year, Hurricane Katrina caused widespread damage to onshore oil storage facilities, releasing 191,000 barrels of oil (LHR 2010). Another 4,530 barrels of oil were released from 70 other smaller spills associated with hurricane damage. Shortly thereafter, Hurricane Rita damaged offshore facilities resulting in 8,429 barrels of oil to be released (USN 2008).

Major oil spills have impacted the Gulf of Mexico for decades (NMFS 2010). Until 2010, the largest oil spill in North America occurred in the Bay of Campeche (1979), when a well “blew out”, allowing oil to flow into the marine environment for nine months, releasing 2.8-7.5 million barrels of oil. Oil from this release eventually reached the Texas coast, including the Kemp’s ridley sea turtle nesting beach at Rancho Nuevo, from where 9,000 hatchlings were airlifted and released offshore (NOAA 2003). Over 7,600 m3 of oiled sand was eventually removed from Texas beaches and 200 gallons of oil were removed from the area around Rancho Nuevo (NOAA 2003). Eight dead and five live sea turtles were recovered during the oil spill event; although cause of deaths were not determined, oiling was suspected to play a part (NOAA 2003). Also in 1979, the oil tanker Burmah Agate collided with another vessel near Galveston, Texas, causing an oil spill and fire that ultimately released 65,000 barrels of oil into estuaries, beachfronts, and marshland along the northern and central Texas coastline (NMFS 2010). Clean-up of these areas was not attempted due to the environmental damage such efforts would have caused. Another 195,000 barrels of oil are estimated to have been burned in a multi-month-long fire aboard the Burmah Agate (NMFS 2010). The tanker Alvenus grounded in 1984 near Cameron, Louisiana, spilling 65,500 barrels of oil which spread west along the shoreline to Galveston (NMFS 2010). One oiled sea turtle was recovered and released (NOAA 2003). In 1990, the oil tanker Megaborg experienced an accident near Galveston during the lightering process and released 127,500 barrels of oil, most of which burned off in the ensuing fire (NMFS 2010).

On April 20, 2010, a fire and explosion occurred aboard the semisubmersible drilling platform Deepwater Horizon roughly 80 km southeast of the Mississippi Delta (NOAA 2010a). The platform had 17,500 barrels of fuel aboard, which likely burned, escaped, or sank with the platform (NOAA 2010a). However, once the platform sank, the riser pipe connecting the platform to the wellhead on the seafloor broke in multiple locations, initiating an uncontrolled release of oil from the exploratory well. Over the next three months, oil was released into the Gulf of Mexico, resulting in oiled regions of Texas, Louisiana, Mississippi, Alabama, and Florida and widespread oil slicks throughout the northern Gulf of Mexico that closed more than one-third of the Gulf of Mexico Exclusive Economic Zone to fishing due to contamination concerns. Apart from the widespread surface slick, massive undersea oil plumes formed, possibly through the widespread use of dispersants, and reports of tarballs washing ashore throughout the region were common. Although estimates vary, NOAA has estimated that 4.9 million barrels of oil were released (Lubchenco et al. 2010). As of September 13, 2010, approximately 3,600 vessels, including skimmers, tugs, barges, and recovery vessels as well as aircraft were assisting in containment and cleanup efforts from the Deepwater Horizon spill, contributing significant acoustic energy to the marine environment.

Amid concerns regarding toxicity and endocrine effects of dispersants, the EPA conducted a series of tests to determine the toxicity of individual dispersants, whether less toxic alternative dispersants were available for use and whether endocrine disruption was possible from dispersant use (EPA 2010a; EPA 2010c). Test organisms were endemic to the Gulf of Mexico—mysid shrimp and the inland silverside. The tests were conducted on mixtures of Louisiana Sweet Crude Oil and eight dispersant products approved for use by the EPA including Corexit 9500A which was used for the Deepwater Horizon spill.

These results confirm that the dispersant used in response to the oil spill in the Gulf, Corexit 9500A, is not distinguishable from other dispersants tested based on the acute toxicity tests for the test species (EPA 2010c). For both the shrimp and the fish species tested all of the dispersants alone were less toxic than the dispersant/oil mixture. These findings agree with information collected by Fingas (2008) from literature reviews of oil spill dispersants. Oil alone was found to be more toxic to mysid shrimp than the eight dispersants when tested alone. Oil alone and the dispersant/oil mixture both had similar toxicity to mysid shrimp in all but one alternative dispersant tested. None of the tests for endocrine disruption indicated that dispersants displayed biologically significant endocrine disrupting activity via the pathways tested. The EPA reports, however, that there were other routes through which chemicals can cause endocrine disruption, as well as other types of toxicity that were not tested (EPA 2010a)

During the response phase to the Deepwater Horizon oil spill (26 April – 20 October 2010) a total of 1,146 sea turtles were recovered, either as strandings or were collected offshore during sea turtle search and rescue operations (Table 40). A total of 720 sea turtles have been verified in the spill zone of which 172 were verified as having been exposed to oil (NOAA 2010c). Response collections during the time of the spill are expected to represent a fraction of the actual species losses, as most individuals likely were not recovered. Kemp’s ridley sea turtles may have been the most affected sea turtle species, as they accounted for almost 71% of all recovered turtles. Green turtles accounted for 17.5% of all recoveries. No leatherbacks were among the sea turtles recovered in the spill response area.

Table 40. Sea turtles recovered in the Deepwater Horizon spill response area (http://www.nmfs.noaa.gov/pr/health/oilspill/turtles.htm).

Sea turtle species	Alive	Dead	Total
Green	172	29	201
Hawksbill	16	0	16
Kemp's ridley	328	481	809
Loggerhead	21	67	88
Unknown	0	32	32
Total	**537**	**609**	**1,146**

Relative to the other species, Kemp’s ridley populations are much smaller, yet recoveries during the Deepwater Horizon oil spill response were much higher. The location and timing of the Deepwater Horizon event were also important factors. In addition to mortalities, the effects of the spill may have included disruptions to foraging and resource availability, migrations, and other unknown effects. How quickly the species returns to the previous fast pace of recovery may depend in part on how much of an impact the Deepwater Horizon event has had on Kemp’s ridley food resources (Balazs 2000). Although we believe that the Deepwater Horizon event had adverse effects on loggerheads, the population level effect was not likely as severe as it was for Kemp’s ridleys. In comparison to Kemp’s ridleys, we believe the relative proportion of the population exposed to the effects of the event was much smaller, the number of turtles recovered (alive and dead) are fewer in absolute numbers, and the overall population size is believed to be many times larger. However, it is likely that impacts to the Northern Gulf of Mexico Recovery

Unit of the northwestern Atlantic loggerhead DPS would be proportionally much greater than the impacts occurring to other recovery units because of impacts to nesting (as described above) and a larger proportion of the NGMRU recovery unit, especially mating and nesting adults, being exposed to the spill. However, the impacts to that recovery unit, and the possible effect of such a disproportionate impact on that small recovery unit to the northwestern Atlantic loggerhead DPS and the species, remain unknown.

Sea turtles may also be harassed by the high level of helicopter activity over Gulf of Mexico waters. It is estimated that between roughly 900,000 and 1.5 million helicopter take-offs and landings are undertaken in association with oil and gas activities in the Gulf of Mexico annually (NRC 1990c; USN 2008). This likely includes numerous overflights of sea turtles, an activity which has been observed to startle and at least temporarily displace sea turtles (USN 2009).

5.2.9 **Seismic Surveys and Oil and Gas Production**

Numerous surveys have been conducted in the northwest Atlantic using seismic airguns, and have the potential to affect ESA-listed seismic surveys. As a general mitigation measure, airguns are shutdown if marine mammals approach too closely, presumably avoiding the potential for temporary or permanent threshold shifts in their hearing. However, some species (such as bowhead whales) appear to be particularly sensitive to seismic, vessel, and industrial sound sounds and may move rapidly up to several kilometers away from the sound source (Gallagher and Hall. 1993; George 2010; Greene 1982; Richardson et al. 1995b; Richardson et al. 1985c; Richardson et al. 1990; Richardson et al. 2004b; Richardson and Williams 2003; Richardson and Williams 2004; Schick and Urban 2000; Streever et al. 2008; Wartzok et al. 1989). Other baleen whales frequently do the same (Malme et al. 1984; Malme et al. 1985; McCauley et al. 2000b; McCauley et al. 1998a; McCauley et al. 1998b; Miller et al. 1999a; Stone and Tasker 2006). From 1968-2003, approximately 997,901 line miles of two-dimensional seismic data were collected in the Gulf of Mexico region, and 212,967 line mi. were collected in the Atlantic region (Epperly 2000). As of April 2011, the Bureau of Ocean Energy Management had received nine applications for Atlantic Outer Continental Shelf seismic survey activities totaling 317,494 line mi.

On 17 March 2011, the Bureau of Ocean Energy Management provided final approval necessary for Petrobras America, Inc. to begin oil and natural gas production at its Cascade-Chinook project in the Walker Ridge area of the Gulf of Mexico. Located approximately 266km from Louisiana in approximately 2,500 m of water, the project is the first deepwater floating production storage offloading facility approved in the United States. The facility has the capability to process oil and natural gas, store the crude oil in tanks in the facility’s hull, and offload the crude to shuttle tankers for transportation to shore. Natural gas processed by the facility will be transported to shore by pipeline (Diez 2000).

In recent years, liquefied natural gas terminals have been proposed at several locations throughout the Atlantic coast and nearshore waters of the Gulf of Mexico in response to the quickly escalating domestic demand for natural gas. Table 41 provides a summary of existing and proposed offshore terminals in the action area. Several existing terminals are in coastal waters near the action area, and others are proposed (Ehrhart and Redfoot 2000). Potential environmental impacts include those associated with additional ship traffic, underwater noise from construction and operation, seawater intakes and discharges, and potential releases of liquefied natural gas. Liquefied natural gas releases can result from equipment leaks or spills during operations. Releases can be accidental (ship collision) or intentional (sabotage or terrorist acts).

Table 41. Existing and proposed offshore liquefied natural gas terminals in the action area.

Facility Name	Location	Status
Gulf Gateway Energy Bridge	Gulf of Mexico, 116 miles offshore of Louisiana	Operational since 2005
Louisiana Offshore Oil Port	Gulf of Mexico, 16 miles southeast of Port Fourchon, Louisiana	Operational since 1981
Neptune Liquified Natural Gas	Massachusetts Bay, 10 miles south of Glouchester, Massachusetts	Operational since 2010
Northeast Gateway	Massachusetts Bay, 13 miles southeast of Glouchester, Massachusetts	Operational since 2008
Main Pass Energy Hub	Gulf of Mexico, offshore of Louisiana 16 miles east of the Mississippi River	Proposed. Application approved in 2007. Issuance of license is pending applicant's ability to meet financial requirements of the Deepwater Port Act.
Port Dolphin	Gulf of Mexico 28 miles offshore of the Tampa Bay area of Florida	Proposed. License issued in 2010.
Bienville Offshore Energy Terminal Port	Gulf of Mexico, 63 miles south of Mobile Point, Alabama	Proposed. Application approved in 2010. Development is temporarily suspended pending development of the natural gas market in the United States.

Sources: Marine Administration 2011; Torp Technology 2011

On 1 December 2010, the Department of Interior announced an updated oil and gas leasing strategy for the Outer Continental Shelf that increased the requirements in the drilling and production stages for equipment, safety, environmental safeguards, and oversight. Areas in the eastern Gulf of Mexico subject to the congressional moratorium on oil and gas exploration and production activities will not be considered for potential leasing before 2017. In addition, the Mid- and South Atlantic Planning Areas are no longer under consideration for potential development through 2017. The western Gulf of Mexico and the central Gulf of Mexico will continue to be considered for potential leasing before 2017 (Phillips 2000).

5.2.10 **Wind Energy**

The development of wind energy facilities offshore of the U.S. east coast has been analyzed over the past several years. The Bureau of Ocean Energy Management assumed that the entire area of each Mid-Atlantic Wind Energy Area would be leased based on the expressions of commercial wind energy interest received. Leases could be issued and site characterization and assessment activities started as early as 2012. Site characterization and assessment activities would occur over a period of about 5.5 years per lease (Henwood 2000). The most advanced in development of these is the Cape Wind Energy project (Cape Cod, Massachusetts) calls for 130 wind turbine generators. The Bureau of Ocean Energy Management approved a construction and operations plan for the project in 2011 (León 2000). Another six-turbine system is proposed off New Jersey, for which state permits were issued in 2011 (Andre M. Landry 2000). Several leases have been issued that would allow for testing and investigation of wind resources at various sites (Henwood 2000).

5.2.11 **Environmental Toxicants**

North Atlantic right whales, as with many marine mammals, are exposed to numerous toxins in their environment, many of which are introduced by humans. Levels of chromium in North Atlantic right whale tissues are sufficient to be mutagenic and cause cell death in lung, skin, or testicular cells and are a concern for North Atlantic right whale recovery (Chen et al. 2009; Wise et al. 2008). The organochlorines DDT, DDE, PCBs, dieldrin, chlordane, HCB, and heptachlor epoxide have been isolated from blubber samples and reported concentrations may underestimate actual levels (Woodley et al. 1991). Mean PCB levels in North Atlantic right whales are greater than any other baleen whale species thus far measured, although less than one-quarter of the levels measured in harbor porpoises (Gauthier et al. 1997a; Van Scheppingen et al. 1996). Organochlorines and pesticides, although variable in concentration by season, do not appear to currently threaten North Atlantic right whale health and recovery (Weisbrod et al. 2000). Flame retardants such as PBDEs (known to be carcinogenic) have also been measured in North Atlantic right whales (Montie et al. 2010).

5.2.12 **Entrainment in Power Plants**

Sea turtles entering coastal or inshore areas have been affected by entrainment in the cooling-water systems of electrical generating plants. At the St. Lucie nuclear power plant at Hutchinson Island, Florida, large numbers of green and loggerhead turtles have been captured in the seawater intake canal in the past several years. Annual capture levels from 1994 - 1997 have ranged from almost 200 to almost 700 green turtles and from about 150 to over 350 loggerheads. Almost all of the turtles are caught and released alive; NMFS estimates the survival rate at 98.5% or greater (1997e). Other power plants in south Florida, west Florida, and North Carolina have also reported low levels of sea turtle entrainment. A biological opinion completed in January 2000 estimates that the operations at the Brunswick Steam Electric Plant in Brunswick, North Carolina, may take 50 sea turtles in any combination annually, that are released alive. NMFS also estimated the total lethal take of turtles at this plant may reach 6 loggerhead, 2 Kemp's ridley or 3 green turtles annually. A biological opinion completed in June 1999 on the operations at the Crystal River Energy Complex in Crystal River, Florida, estimated the level of take of sea turtles in the plant's intake canal may reach 55 sea turtles with an estimated 50 being released alive every two years.

5.2.13 **Pollution**

Chemical pollution of the freshwater, estuarine, and marine environment is a pervasive problem throughout the US, although the significance of specific pollutants varies between regions or watersheds. The Gulf of Mexico is a sink for massive levels of pollution from a variety of marine and terrestrial sources, which ultimately can interfere with ecosystem health and particularly that of sea turtles (see Status of listed resources section). Sources include the petrochemical industry in and along the Gulf of Mexico, wastewater treatment plants, septic systems, industrial facilities, agriculture, animal feeding operations, and improper refuse disposal. The Mississippi River drains 80% of United States cropland (including the fertilizers, pesticides, herbicides, and other contaminants that are applied to it) and discharges into the Gulf of Mexico near the action area (MMS 1998). Agricultural discharges, as well as discharges from large urban centers (ex.: Houston and New Orleans) contribute contaminants as well as coliform bacteria to Gulf of Mexico habitats (Garbarino et al. 1995). These contaminants can be carried long distances from terrestrial or nearshore sources and ultimately accumulate in offshore pelagic environments (USCOP 2004). The ultimate impacts of this pollution are poorly understood.

Significant attention has been paid to nutrient enrichment of Gulf of Mexico waters, which leads to algal blooms (including harmful algal blooms), oxygen depletion, loss of seagrass and coral reef habitat, and the formation of a hypoxic “dead zone” (USCOP 2004). This hypoxic event occurs annually from as early as February to as late as October, spanning roughly 12,700 km2 (although in 2005 the “dead zone” grew to a record size of 22,000 km2) from the Mississippi River Delta to Galveston, Texas (LUMCON 2005; MMS 1998; Rabalais et al. 2002; USGS 2010). Although sea turtles do not extract oxygen from sea water, numerous staple prey items of sea turtles, such as fish, shrimp, and crabs, do and are killed by the hypoxic conditions (Craig et al. 2001). More generally, the “dead zone” decreases biodiversity, alters marine food webs, and destroys habitat (Craig et al. 2001; Rabalais et al. 2002). High nitrogen loads entering the Gulf of Mexico from the Mississippi River are the likely culprit; nitrogen concentrations entering the Gulf of Mexico have increased three fold over the past 60 years (Rabalais et al. 2002). Through these indirect effects, sea turtles are unable to utilize this region during this time for foraging and can only utilize it to a limited extent when the “dead zone” does not occur while the underlying food web recovers.

5.2.14 **Commercial Fisheries**

Three of the biggest threats to sea turtles result from harvest for commercial and subsistence use. These include egg harvest, the harvest of females on nesting beaches, and directed hunting of sea turtles in foraging areas. These factors have led to the precipitous declines in worldwide sea turtle populations. In the Atlantic, green sea turtles are captured and killed in turtle fisheries in Colombia, Grenada, the Lesser Antilles, Nicaragua, St. Vincent and the Grenadines; the turtle fishery along the Caribbean coast of Nicaragua, by itself, has captured more than 11,000 green sea turtles annually over the past decade (Bräutigam and Eckert 2006b; Lagueux 1998). While these threats have been largely eliminated in Florida due to successful conservation measures, the hunting of juvenile and adult turtles continues both legally and illegally in many foraging areas where green sea turtles originating from Florida are known to occur (Chacon 2002; Fleming 2001). The killing of nesting hawksbill females continues to threaten the stability of hawksbill subpopulations in many areas. The centuries-old historic trade in tortoise shell greatly impacted hawksbill populations in the Insular Caribbean. Increases in nesting hawksbills in the region coincide with the decline of international trade in hawksbill shell (Milliken and Tokunaga 1987), and in particular with the 90% reduction in the annual take of large hawksbills from Cuban waters (Carrillo et al. 1999).

5.2.14.1 *Entrapment and Entanglement in Fishing Gear*

Fisheries interactions are a significant problem for several marine mammal species and particularly so for humpback whales. Aside from the potential of entrapment and entanglement, there is also concern that many marine mammals that die from entanglement in commercial fishing gear tend to sink rather than strand ashore, thus making it difficult to accurately determine the frequency of mortalities. Entanglement may also make whales more vulnerable to additional dangers, such as predation and ship strikes, by restricting agility and swimming speed. Like fin whales, humpback whales have been entangled by fishing gear off Newfoundland and Labrador, Canada. A total of 595 humpback whales were reported captured in coastal fisheries in those two provinces between 1969 and 1990, of which 94 died (Lien 1994; Perkins and Beamish 1979). Along the Atlantic coast of the U.S. and the Maritime Provinces of Canada, there were 160 reports of humpback whales being entangled in fishing gear between 1999 and 2005 (Cole et al. 2005c; Nelson et al. 2007c). Of these, 95 entangled humpback whales were confirmed, with 11 whales sustaining injuries and nine dying of their wounds.

Fisheries interactions are also a particular problem for North Atlantic right whales (Figure 24). Aside from the potential of entrapment and entanglement, there is also concern that many marine mammals that die from entanglement in commercial fishing gear tend to sink rather than strand ashore, thus making it difficult to accurately determine the frequency of such mortalities. Entanglement may also make whales more vulnerable to additional dangers, such as predation and ship strikes, by restricting agility and swimming speed. Along the Atlantic coast of the US and the Maritime Provinces of Canada, there were 46 confirmed reports of North Atlantic right whales entangled in fishing gear between 1990 and 2007 (Cole et al. 2005a; Nelson et al. 2007a; Waring et al. 2009). Of the 39 reports that the NMFS could confirm, North Atlantic right whales were injured in five of the entanglements and killed in four entanglements. Three of the 24 entangled whales between 2004 and 2008 died and one other resulted in serious injury (Glass et al. 2009). Recent efforts to disentangle right whales have met with success (Anonmyous. 2009). However, over 60% of the North Atlantic right whale population show some evidence of entanglement (Hamilton et al. 1998). In August 1993, a dead sperm whale, with longline gear wound tightly around the jaw, was found floating about 32 km off Maine.

Figure 24. A North Atlantic right whale entangled in fisheries gear off Florida, with Georgia Department of Natural Resources and Coastwise Consulting staff attempting to cut rope off (Credit: EcoHealth Alliance and Georgia Department of Natural Resources, ESA permit number 932-1905).

Fishery interaction remains a major factor in sea turtle recovery and, frequently, the lack there of. Wallace et al. (2010) estimated that worldwide, 447,000 turtles are killed each year from bycatch in commercial fisheries. NMFS (2002a) estimated that 62,000 loggerhead sea turtles have been killed as a result of incidental capture and drowning in shrimp trawl gear. Although turtle excluder devices and other bycatch reduction devices have significantly reduced the level of bycatch to sea turtles and other marine species in US waters, mortality still occurs. The fisheries that have the most significant demographic effect on sea turtles are the Gulf of Mexico shrimp trawl fisheries. The estimated annual number of interactions and mortalities between sea turtles and shrimp trawls in the Gulf shrimp fisheries (state and federal) are believed to have declined as compared to interactions prior to turtle exclusion device regulations (Epperly et al. 2002) (Table 42). Although participants in this and other fisheries are required to use Turtle Exclusion Devices, which are estimated to reduce the number of sea turtles trawlers capture by as much as 97%, each year these fisheries are expected to capture about 185,000 sea turtles annually and kill about 5,000 of them. Loggerhead sea turtles account for most of this these: each of these fisheries is expected to capture about 163,000 loggerhead sea turtles, killing almost 4,000 of them. However, more recent estimates from suggest interactions and mortality has decreased from pre-regulatory periods, with a conservative estimate of 26,500 loggerheads captured annually in U.S. Atlantic fisheries causing mortality to 1,400 individuals per year (Finkbeiner et al. 2011). These are followed by green sea turtles: about 18,700 green sea turtles are expected to be captured each year with more than 500 of them dying as a result of their capture (NMFS 2002b). Each year, various fisheries capture about 2,000 loggerhead sea turtles in Pamlico Sound, of which almost 700 die (Finkbeiner et al. 2011).

Table 42. Estimated annual interactions between sea turtles and shrimp trawls in the Gulf of Mexico shrimp fisheries associated estimated mortalities based on 2007 Gulf effort data taken from Nance et al. (2008)

Species	Estimated interactions	Estimated mortalities
Leatherback	520	15
Loggerhead	23,336	647
Kemp's ridley	98,184	2,716
Green	11,311	319

Mortality of leatherbacks in the U.S. shrimp fishery is now estimated at 54 turtles per year. Data collected by the NEFSC Fisheries Observer Program from 1994 through 1998 (excluding 1997) indicate that a total of 37 leatherbacks were incidentally captured (16 lethally) in drift gillnets set in offshore waters from Maine to Florida during this period. Observer coverage for this period ranged from 54 to 92%. Trinidad and Tobago's Institute for Marine Affairs estimated that more than 3,000 leatherbacks were captured incidental to gillnet fishing in the coastal waters of Trinidad in 2000. Half or more of the gravid turtles in Trinidad and Tobago waters may be killed (Lee Lum 2003), though many of the turtles do not die as a result of drowning, but rather because the fishermen butcher them in order to get them out of their nets (NMFS 2001a).

Leatherback sea turtles are known to drown in fish nets set in coastal waters of Sao Tome, West Africa (Castroviejo et al. 1994; Graff 1995). Gillnets are one of the suspected causes for the decline in the leatherback turtle population in French Guiana (Chevalier et al. 1999), and gillnets targeting green and hawksbill turtles in the waters of coastal Nicaragua also incidentally catch leatherback turtles (Lagueux 1998). Observers on shrimp trawlers operating in the northeastern region of Venezuela documented the capture of six leatherbacks from 13,600 trawls (Marcano and Alió-M 2000). An estimated 1,000 mature female leatherback turtles are caught annually off of Trinidad and Tobago with mortality estimated to be between 50-95% (Eckert and Lien 1999). However, many of the turtles do not die as a result of drowning, but rather because the fishermen butcher them in order to get them out of their nets (NMFS 2001a). There are known to be many sizeable populations of leatherbacks nesting in West Africa, possibly as many as 20,000 females nesting annually (Fretey 2001b). In Ghana, nearly two thirds of the leatherback turtles that come up to nest on the beach are killed by local fishermen.

Portions of the Atlantic pelagic fisheries for swordfish, tuna, shark, and billfish also operate in the action area and capture and kill the second highest numbers of sea turtles along the Atlantic coast. These fisheries include purse seine fisheries for tuna, harpoon fisheries for tuna and swordfish, commercial and recreational rod and reel fisheries, gillnet fisheries for shark, driftnet fisheries, pelagic longline fisheries, and bottom longline fisheries. Lewison et al. (2004)

estimated that 30,000-60,000 leatherbacks were taken in all Atlantic longline fisheries in 2000 (including the U.S. Atlantic tuna and swordfish longline fisheries, as well as others). Between 1986 and 1995, this fishery captured and killed one north Atlantic right whale, two humpback whales, and two sperm whales. Between 1992 and 1998, the longline components of these fisheries are estimated to have captured more than 10,000 sea turtles (4,585 leatherback sea turtles and 5,280 loggerhead sea turtles), killing 168 of these, disincluding sea turtles that might have died after being released (Johnson et al. 1999; Yeung 1999). Since then, all components of these fisheries are estimated to capture about 1,350 sea turtles each year, killing 345. Finkbeiner et al. (2011) estimated that annual bycatch interactions total 1,400 leatherbacks annually for U.S. Atlantic fisheries (resulting in roughly 40 mortalities).

On 4 July 2004, NMFS published a final rule to implement management measures to reduce bycatch and bycatch mortality of Atlantic sea turtles in the Atlantic pelagic longline fishery (6979 FR 40734). The management measures include mandatory circle hook and bait requirements, and mandatory possession and use of sea turtle release equipment to reduce bycatch mortality. The rulemaking, based on the results of the three-year Northeast Distant Closed Area research experiment and other available sea turtle bycatch reduction studies, is expected to significantly reduce sea turtle mortality from pelagic longlines.

In 2008, SEFSC observer programs and subsequent analyses indicated that the overall amount and extent of incidental take for sea turtles specified in the incidental take statement of the 2005 opinion on the reef fish fishery had been severely exceeded by the bottom longline component of the fishery (approximately 974 captures and at least 325 mortalities estimated for the period July 2006-2007). The Gulf of Mexico Fishery Management Council developed a long-term management strategy via a new amendment (Amendment 31 to the Reef Fish FMP). The amendment included a prohibition on the use of bottom longline gear in the Gulf of Mexico reef fish fishery, shoreward of a line approximating the 35-fathom contour east of Cape San Blas, Florida, from June through August; a reduction in the number of bottom longline vessels operating in the fishery via an endorsement program and a restriction on the total number of hooks that may be possessed onboard each Gulf of Mexico reef fish bottom longline vessel to 1,000, only 750 of which may be rigged for fishing. These changes are expected to greatly reduce the mortality of loggerhead sea turtles resulting from the operation of this fishery.

Observation of the directed highly migratory shark fisheries has been ongoing since 1994, but a mandatory program was not implemented until 2002. Neritic juvenile and adult loggerhead sea turtles are the primary species taken, but leatherback sea turtles have also been observed caught and a few observations have not been identified. From 1994-2002, observers covered 1.6% of all hooks, observing bycatch of 31 loggerhead, 4 leatherback, and 8 unidentified sea turtles with estimated annual average take levels of 30, 222, and 56, respectively (NMFS 2003).

Portions of the Atlantic sea scallop fisheries also operate in the action area off North Carolina and capture and kill the third highest numbers of sea turtles along the Atlantic coast. These fisheries are expected to capture about 750 loggerhead sea turtles each year, killing about 480 of them. Although these fisheries are only expected to capture 2 green, leatherback, and Kemp’s ridley sea turtles each year, all of these turtles might die as a result of their capture.

In addition to commercial bycatch, recreational hook-and-line interaction also occurs. Cannon and Flanagan (1996) reported that from 1993 to 1995, at least 170 Kemp's ridley sea turtles were hooked or tangled by recreational hook-and-line gear in the northern Gulf of Mexico. Of these, 18 were dead stranded turtles, 51 were rehabilitated turtles, five died during rehabilitation, and 96 were reported as released by fishermen.

5.2.14.2 *Commercial Whaling and Subsistence Hunting*

Large whale population numbers in the action areas have historically been impacted by commercial exploitation, mainly in the form of whaling. Between 1969-1990, 14 fin whales were captured in coastal fisheries off Newfoundland and Labrador; of these seven are known to have died because of capture (Lien 1994; Perkins and Beamish 1979).

5.2.15 Ongoing U.S. Navy Training and Testing Activities in the Action Area

Ongoing U.S. Navy training and testing activities in the AFTT Action Area are discussed here as part of the baseline. Section 7 consultations for "Phase I" U.S. Navy training and testing activities occurring from approximately 2009 through 2014 include consultations and biological opinions on Atlantic Fleet Active Sonar Training (AFAST), Gulf of Mexico Range Complex, East Coast Range Complexes, and the Panama City Range Complex. This biological opinion assesses Phase II, Atlantic Fleet Training and Testing (AFTT) which includes all activities assessed in Phase I consultations in addition to activities such as unit-level training, pierside testing, USWTR operations, and transit activities. Therefore, it is important to assess the anticipated impacts of specific, new training and testing activities and changes in levels of ongoing activities as proposed for AFTT on top ongoing training and testing (2009-2014). Below, we summarize our conclusions of the Phase I consultations specific to those activities or range complexes.

5.2.15.1 *U.S. Navy Training and Testing, Atlantic Fleet Active Sonar Training (AFAST)*

The instances of harassment from the most recent biological opinion identified in Table 43 generally represent changes from foraging, resting, milling, and other behavioral states that require lower energy expenditures to traveling, avoidance, and behavioral states that require higher energy expenditures. Therefore, takes represent significant disruptions of the normal behavioral patterns of the animals that are expected to be exposed to the U.S. Navy's AFAST activities.

Table 43. Expected takes resulting from exposure to active sonar during AFAST activities.

Whale species	Estimated takes		Form of "take"
	Annually	Total	
Blue	881	1,762	Harassment
Fin	970	1,940	Harassment
Humpback	4,622	9,244	Harassment
North Atlantic right	733	1,466	Harassment
Sei	1,163	2,326	Harassment
Sperm	10,734	21,468	Harassment

Injury or mortality potentially resulting from exposure (potential collision) to U.S. Navy vessels during active sonar training activities along the Atlantic Coast or in the Gulf of Mexico was not quantified in this consultation. Because of their hearing sensitivities, we generally expect blue, fin, and sei whales to change their behavior in response to cues from the vessels rather than to the sound field produced by active sonar and the estimates in this list reflect that expectation. We assume that humpback and sperm whales would changes their behavior in response to the sound field produced by active sonar as well as cues from the vessels involved in training exercises. Based on the hearing sensitivities of sea turtles, no "take" of sea turtles is anticipated due to active sonar.

5.2.15.1.1 Observations from AFAST Major Training Events (August 2009-August 2012)

During the period (22 January 2009 to 1 August 2012), the U.S. Navy conducted 35 Major Training Exercises (MTE) within the AFAST Study Area. This section is a summary of these exercises/events and associated marine animal sightings and mitigation events as reported in the DoN. 2013. Draft – Comprehensive Exercise and Marine Species Monitoring Report For the U.S. Navy's Atlantic Fleet Active Sonar Training (AFAST) and Virginia Capes, Cherry Point, Jacksonville, and Gulf of Mexico Range Complexes 2009-2012. Department of the Navy, United States Fleet Forces Command, Norfolk, Virginia.

During MTEs Navy collected detailed marine mammal sighting related data that included the number and type of animals sighted, location, range to sighting, and weather data (wave height and visibility). A summary of the MTE sighting related data is included in the table below.

Table 44. AFAST Study Area Major Training Exercise Sighting Data Summary by OPAREA.

Marine Animal Species	# of Sightings (22 Jan 2009 – 1 August 2012)	# of Animals	Mean Range to Sightings (yds)	Mean Wave Height (ft.)	Mean Visibility (nm)
Virginia Capes Range Complex (VCOA)					
Dolphin	4	33	675	1.8	8.5
Whale	7	16	1,000	1.9	7.6
Turtle					
Generic	1	1	Unknown	1.8	8.1
Cherry Point Range Complex (CPOA)					
Dolphin	217	1,199	440	2.5	9.6
Whale	29	61	912	1.8	10
Turtle	18	18	542	1.5	9.9
Generic	1	1	Unknown	1.9	9.6
Jacksonville Range Complex (JAX)					
Dolphin	214	1,279	348	2.7	10.1
Whale	38	90	1,564	2.8	9.4
Turtle	28	37	356	2.2	10
Generic	5	7	150	Unknown	10

Total	**562**	**2,742**	**665**	**2.15**	**9.5**

This sighting data revealed the following:

- Out of 435 dolphin sightings during MTE's, 132 (30.3%) included "bowriding" behavior.
- The mean range to all dolphin sightings was 488 yards.
- The mean range to all whale sightings was 1,159 yards.
- The mean range to all turtle sightings was 449 yards.
- The mean range to all reported sightings was 665 yards.

There were 35 individual MTEs that took place in the AFAST Study Area from 22 January 2009 to 1 August 2012. These MTEs are summarized in the table below.

Table 45. AFAST Study Area Major Training Exercise Summary.

Exercise Type	22 Jan 2009 – 1 Aug 2009	2 Aug 2009 – 1 Aug 2010	2 Aug 2010 – 1 Aug 2011	2 Aug 2011 – 1 Aug 2012	Reporting Period Totals
COMPTUEX	3	3	2	3	11
JTFEX	0	1	2	2	5
IAC II	3	3	3	4	13
SEASWITI	1	3	2	0	6
Total	**7**	**10**	**9**	**9**	**35**

There were 28 total mitigation events (MFAS powered down or shut down) due to the sighting of marine mammals or sea turtles during MTEs from 22 January 2009 to 1 August 2012. These mitigation events are summarized in Table 3 below. The last column, Excessive Mitigation, is defined as the implementation of powering down or shutting down of MFAS when applied beyond mandated safety zones or at ranges beyond what was required. Navy is very concerned when excessive mitigations are applied as this directly contributes to an interruption in training which impacts training effectiveness.

Table 46. AFAST Study Area Mitigation Events

Marine Animal Species	Range of Detection (Yards, < 200, 200-500, 500-1000, 1000-2000, > 2000)	Mitigation Measure Implemented	Excessive Mitigation (Yes/No)
22 January 2009 – 1 August 2009			
Dolphin	< 200	Sonar shut down	No
Dolphin	< 200	Sonar shut down	No
Dolphin	< 200	Sonar shut down	No
Dolphin	< 200	Sonar shut down	No
Dolphin	Not reported	Sonar powered down	Yes
Dolphin	Not reported	Sonar shut down	Yes
Dolphin	Not reported	Sonar shut down	Yes

Marine Animal Species	Range of Detection (Yards, < 200, 200-500, 500-1000, 1000-2000, > 2000)	Mitigation Measure Implemented	Excessive Mitigation (Yes/No)
Whale	**< 200**	**Sonar shut down**	**No**
Whale	**< 200**	**Sonar shut down**	**No**
Whale	**> 2000**	**Sonar shut down**	**Yes**
2 August 2009 – 1 August 2010			
Dolphin	< 200	Sonar shut down	No
Dolphin	1000-2000	Sonar shut down	Yes
Dolphin	Not reported	Sonar powered down	Yes
Dolphin	Not reported	Sonar powered down	Yes
Dolphin	200-500	Sonar powered down	No
Whale	**1000-2000**	**Sonar shut down**	**Yes**
Whale	**> 2000**	**Sonar shut down**	**Yes**
2 August 2010 – 1 August 2011			
Turtle	**< 200**	**Sonar shut down**	**No**
Dolphin	< 200	Sonar shut down	No
Dolphin	< 200	Sonar shut down	No
Whale	**500-1000**	**Sonar powered down**	**No**
2 August 2011 – 1 August 2012			
Dolphin	< 200	Sonar shut down	No
Dolphin	1000-2000	Sonar shut down	Yes
Dolphin	1000-2000	Sonar powered down	No
Dolphin	1000-2000	Sonar powered down	No
Dolphin	Not reported	Sonar shut down	Yes
Whale	**500-1000**	**Sonar shut down**	**Yes**
Whale	**Not reported**	**Sonar shut down**	**Yes**

There were 562 reported sightings of at least 2,742 marine mammals and sea turtles during MTEs in the AFAST Study Area from 22 January 2009 to 1 August 2012. These sightings are summarized by MFAS in active or passive mode at the time of sighting in the table below.

Table 47. AFAST Study Area Sighted Marine Mammals and Sea Turtles.

Marine Animal Species	22 Jan 2009 – 1 Aug 2009	2 Aug 2009 – 1 Aug 2010	2 Aug 2010 – 1 Aug 2011	2 Aug 2011 – 1 Aug 2012	Reporting Period Totals
Animals sighted while MFAS Active					
Dolphin	72	19	23	25	139
Whale	**9**	**10**	**5**	**5**	**29**
Pinniped	0	0	0	0	0
Turtle	**0**	**0**	**1**	**0**	**1**
Generic	0	0	2	0	2

Marine Animal Species	22 Jan 2009 – 1 Aug 2009	2 Aug 2009 – 1 Aug 2010	2 Aug 2010 – 1 Aug 2011	2 Aug 2011 – 1 Aug 2012	Reporting Period Totals
Subtotal while Active	81	29	31	30	171
Animals sighted while MFAS Passive					
Dolphin	304	273	618	1,177	2,372
Whale	**45**	**22**	**17**	**54**	**138**
Pinniped	0	0	0	0	0
Turtle	**12**	**5**	**20**	**17**	**54**
Generic	2	0	4	1	7
Subtotal while Passive	363	300	659	1,249	2,571
Total	**444**	**329**	**690**	**1,279**	**2,742**

The three categories of mitigation measures (Personnel Training, Lookout and Watchstander Responsibility, and Operating Procedures) outlined in the AFAST FEIS/OEIS of December 2008 and approved by NMFS in subsequent LOAs were designed to mitigate exposure of marine mammals and sea turtles to sonar. During the 35 MTEs in the AFAST Study Area from 22 January 2009 to 1 August 2012, prescribed NMFS mitigation zones were either appropriately applied in cases where marine mammals and sea turtles were observed within the applicable zone, or excessive mitigation measures were applied, which is overly conservative, but does not influence evaluating the effectiveness of mitigation. During the entire reporting period, there was only one instance, out of 562 sightings, where a ship neglected to mitigate adequately for a marine mammal sighted within 1,000 yards (99.8% effectiveness). Fleet commanders, aircrews, and ship watch teams continue to improve individual awareness, mitigation execution, and reporting practices. This improvement can be attributed to pre-exercise planning practices, mandatory Marine Species Awareness Training, adherence to required MFAS mitigation zones, and application of lessons learned in marine animal sighting and reporting. Through increased awareness, Navy personnel have become more effective at implementing mitigation for marine mammals that are encountered. It is difficult to assess the efficacy of mitigation measures at reducing the magnitude of or avoiding potential impacts to marine species that are not observed.

Deep diving animals were not identified during any MTEs. If exposure did occur, the Navy assesses that these animals would not be exposed to significant levels for long periods based on the moving nature of hull-mounted MFAS use, and even less exposure from less-frequent and lower-power aviation-deployed MFAS systems (dipping sonar, sonobuoys). During a one-hour dive by a beaked whale or sperm whale, a MFAS ship moving at a nominal speed of 10 knots could transit up to 10 nm from its original location, well beyond ranges predicted to have significant exposures.

Table 46 lists the 28 mitigation events where sonar was active and ships took action to reduce or eliminate inadvertent exposure of marine mammals and sea turtles to sonar. With or without mitigation, given the rapid relative motion of ships maneuvering at sea and the independent marine mammal movement, the time any given animal would be exposed to MFAS from surface ships is likely to be limited. Of those 28 mitigations listed in Table 46, 13 were conducted in excess of mandated safety zones where ships powered down or shut down sonar at ranges beyond what was required. Although 13 out of 28 total events (46%) is a high number of excessive mitigations, the percentage of excessive mitigations for ships in AFAST MTEs has been trending downward, with 9 excessive mitigation events over the first two reporting years and only 4 excessive mitigation events over the past 2 reporting years. This reduction in over-mitigating can be attributed to increased training and familiarity with the mitigation measures and leadership's focus on maximizing realistic active sonar ASW training.

Additionally, there were 15 reported instances of Navy ships proactively maneuvering to avoid marine mammals or sea turtles or to avoid crossing paths with marine animals.

In support of the 35 MTEs during the reporting period, the Navy conducted over 17,590 hours of environmental awareness training, including the Marine Species Awareness Training DVD, for 13,019 Navy personnel prior to these exercises. While at sea, the Navy spent over 184,127 hours of surface ship and aerial visual observation toward the detection of marine mammals and sea turtles. Additionally, over 4,196 hours were spent documenting and reporting marine animal sightings and mitigation events.

Since the actual hours of active sonar use is classified, the following data is presented in a format to ensure protection of the information and still provide the reader with meaningful results. The data showed animals are sighted less than 2% of the time during MTEs, less than 1% while sonar was passive and less than 5% while sonar was active.

Table 48. AFAST Study Area Sighted Marine Mammals and Sea Turtles

Sonar Active/Passive	Percent of Time Active/Passive During MTE	# of Sightings	Percent of Sightings
January 2009 – August 2012			
Active	9.1%	500	29.3%
Passive	90.9%	1207	70.7%

5.2.15.2 *U.S. Navy Training and Testing, East Coast Range Complexes (Northeast Operating Areas and Virginia Capes, Cherry Point, and Jacksonville Range Complexes)*

Table 49 indicates the number of different endangered and threatened species that are likely to be "taken" annually as a result of their exposure to the training activities (excluding active sonar) on East Coast Training Ranges from 5 June 2012 through 4 June 2014. Sea turtles included in the category "hardshell" sea turtles include green, hawksbill, Kemp's ridley and members of the Northwest Atlantic loggerhead DPS.

Table 49. Anticipated incidental take of ESA species within U.S. Navy East Coast Training Range Complexes.

Whale or Sea Turtle Species	Operating Area							
	Northeast		Virginia Capes		Cherry Point		Jacksonville	
	Harass	Harm	Harass	Harm	Harass	Harm	Harass	Harm
Blue	0	0	0	0	0	0	0	0
Fin	0	0	2	0	0	0	0	0
Humpback	0	0	2	0	0	0	0	0
North Atlantic right	0	0	0	0	0	0	0	0
Sei	0	0	0	0	0	0	0	0
Sperm	0	0	2	0	0	0	0	0
Hardshell sea turtles	0	0	300	2	0	0	11	1
Kemp's ridley	0	0	555	5	0	0	2	0
Leatherback	0	0	9	0	0	0	11	1
Northwest Atlantic loggerhead	0	0	466	8	0	0	19	1

Anticipated impacts from harassment include changes from foraging, resting, milling, and other behavioral states that require lower energy expenditures to traveling, avoidance, and behavioral states that require higher energy expenditures and, therefore, would represent significant disruptions of the normal behavioral patterns of the animals that have been exposed. Behavioral responses that result from stressors associated with these training activities are expected to be temporary and would not affect the reproduction, survival, or recovery of these species. Instances of harm identified generally represent animals that would have been exposed to underwater detonations at 205 dB re μPa2-s or 13 psi, which corresponds to an exposure in which 50% of exposed individuals would be expected to experience rupture of their tympanic membrane, an injury that correlates with measures of permanent hearing impairment (specifically, a 30% incidence of permanent loss of hearing sensitivity or PTS) (Ketten 1998c).

U.S. Navy aerial bombing training in the ocean off the southeast U.S. coast involving drops of live ordnance (500 and 1,000-lb bombs) have been estimated to have injured or killed 84 loggerhead, 12 leatherback, and 12 green or Kemp's ridley sea turtles, in combination (NMFS 1997). From 2009 to 2012, NMFS issued a series of biological opinions to the U.S. Navy for training activities occurring within their Northeast, Virginia Capes, Cherry Point and Jacksonville Range Complexes that anticipated annual levels of take of listed species incidental to those training activities through 2014. During the proposed activities 2 fin whales, 2 humpback whales, 2 sperm whales, 344 hardshell sea turtles (any combination of green hawksbill, Kemp's ridley or Northwest Atlantic loggerhead sea turtles), 644 Kemp's ridley sea turtles, 21 leatherback sea turtles and 530 NW Atlantic loggerhead sea turtles per year are expected to be harassed as a result of their behavioral responses to mid- and high frequency active sonar transmissions. Another six Kemp's ridley and five Northwest Atlantic loggerhead turtles per year are expected to be injured during exposure to underwater detonations.

5.2.15.3 *U.S. Navy Training and Testing, Gulf of Mexico Range Complex*

The amount of incidental take listed species are expected to be exposed to from March 2012-March 2014 include five instances of harassment annually, generally involving changes from foraging, resting, milling, and other behavioral states that require lower energy expenditures to traveling, avoidance, and behavioral states that require higher energy expenditures and, therefore, represent significant disruptions of the normal behavioral patterns of the animals that are expected to be exposed to the training activities (excluding active sonar) or research, development, test, and evaluation activities associated with the Gulf of Mexico Range Complex. No sea turtle takes are expected.

5.2.15.4 *U.S. Navy Testing, Panama City Range Complex Testing*

Table 50 identifies the expected "take" as a result of activities in the Panama City Range Complex from 2012-2014. The instances of harassment identified in the table below would generally represent changes from foraging, resting, milling, and other behavioral states that require lower energy expenditures to traveling, avoidance, and behavioral states that require higher energy expenditures. Therefore, they would represent significant disruptions of the normal behavioral patterns of the animals that are expected to be exposed.

Table 50. Expected "takes" of listed individuals due to exposure to activities at the Naval Surface Warfare Center – Panama City Division.

Species	Estimated "take"		Form of "take"
	Annually	Total	
Sperm whale	2	4	Harassment
Leatherback sea turtle	3	6	Harassment
Northwest Atlantic loggerhead sea turtle	4	8	Harassment
Hardshell sea turtle (green, hawksbill, or Kemp's ridley)	3	6	Harassment

5.2.15.5 *Construction of the Undersea Warfare Training Range*[6]

A new training facility is being developed to aid in anti-submarine warfare in the Jacksonville Undersea Warfare Training Range. This area will be instrumented, support fixed-wing aircraft, helicopters, surface ships, and submarines, and employ non-explosive torpedoes. Apart from

[6] USWTR is situated in a portion of the JAX operating area. This BIOP considered the impacts from activities anticipated to occur within the USWTR and analyzed in the Navy's FEIS appendix H. All references to JAX operating area, within this BiOP include an analysis of the impacts of USWTR activities.

aircraft and vessel noise, various sonar systems, including sonobuoys, dipping sonar, torpedo guidance, as well as towed and hull-mounted sonar arrays will be used. An EIS has been developed in association with this facility and its activities. NMFS completed consultation in 2009 that analyzed construction and operation of the USWTR. USWTR has not been constructed at this time. Activities that will occur in the USWTR are included in this consultation. Therefore, only the construction aspect of USWTR is considered part of the baseline.

5.2.16 Other U.S. Military Training and testing along the East Coast and in the Gulf of Mexico

The air space over Gulf of Mexico is used extensively by the Department of Defense for conducting various air-to-air and air-to-surface operations. Nine military warning areas and five water test areas are located within the Gulf of Mexico, totaling 21 million acres. In addition, six blocks in the western Gulf of Mexico are used by the Navy for mine warfare testing and training. Portions of the Eglin Water Test Areas comprise an additional 0.5 million ac. Incidental take has been authorized for Eglin Gulf Test and Training Range (NMFS 2004a), the Precision Strike Weapons Tests (NMFS 2005a), the Santa Rosa Island Mission Utilization Plan (NMFS 2005a) and Naval Explosive Ordnance Disposal School (NMFS 2004a) in the Gulf of Mexico.

5.2.16.1 *U.S. Marine Corps training in the Cherry Point Range Complex*

Table 51 identifies the likely take associated with Marine Corps activities in the Cherry Point Range Complex.

Table 51. Incidental take associated with U.S. Marine Corps training at BT-9 and BT-11 in the Cherry Point Range Complex.

Species	MCAS Cherry Point water ranges						
	Boat maneuvers (BT-9 & BT-11)		Ordnance/munitions delivery (BT-9 & BT-11)		Underwater explosions (BT-9 only)		
	Harass	Harm (injury, mortality) from vessel strike	Harass	Harm (injury, mortality) from direct strike	Harass (TTS and other behavioral impacts)	Harm	
						Injury	Mortality
Green sea turtle Kemp's ridley sea turtle Leatherback sea turtle Northwest Atlantic DPS Loggerhead sea turtle	10 of any species per year	1 of any species over a 10-year period	10 of any species per year	2 of any species over a 10-year period	23 per year	1 per year (PTS)	1 over a 10-year period
Atlantic sturgeon	10 per year	1 over a 10-year period	10 per year	-	10 per year	1 over a 10-year period	1 over a 10-year period

5.2.16.2 *Eglin Air Force Base Gulf Test and Training Range*

Air-to-surface gunnery missions at EGTTR involve surface impacts of projectiles and small underwater detonations with the potential to affect cetaceans, sea turtles and sturgeon.

5.2.16.3 *Naval Explosive Ordnance Disposal School, Eglin Air Force Base*

The mission of Naval Explosive Ordnance Disposal School is to train Navy divers to detect, recover, identity, evaluate, render safe, and dispose of unexploded ordnance that constitutes a threat to people, material, installations, ships, aircraft, and operations. The goal of the training is to give Naval Explosive Ordnance Disposal School students the tools and techniques to implement mine counter-measures through real scenarios. Detonations involve mine hunting by divers and requires mine clearance operations. The students would be taught established techniques for neutralizing mines by diving and hand-placing charges adjacent to inert mines. The detonation of small, live explosive charges adjacent to the mine disables the mine function, and inert mines will be utilized for other training purposes.

The training exercises are proposed to occur offshore of Santa Rosa Island eight times annually. Four days of on-site training are expected at the test sites per exercise. Two of these four days will be utilized to lay the inert mines prior to the training. The other two days will involve live detonations in the Gulf of Mexico. Each demolition training event would involve a maximum of 5 detonations. A total of eight exercises involving up to 40 detonations annually are expected as a result of the action. Half of the annual detonations would involve 5-1b NEW charges, and half would involve 10-Ib NEW charges. One large safety vessel and five MK V inflatable 10-ft rubber boats with 50-horsepower (HP) engines would be used to access the Gulf of Mexico waters during training activities.

5.2.17 **Vessel Approaches–Commercial and Private Marine Mammal Watching**

Although considered by many to be a non-consumptive use of marine mammals with economic, recreational, educational and scientific benefits, marine mammal watching is not without potential negative impacts. Whale-watching vessels are known to influence sperm whale behavior (Richter et al. 2006). Whale watching has the potential to harass whales by altering feeding, breeding, and social behavior or even injure them if the vessel gets too close or strikes the whale. Another concern is that preferred habitats may be abandoned if disturbance levels are too high. In the Notice of Availability of Revised Whale Watch Guidelines for Vessel Operations in the Northeastern United States (64 FR 29270; June 1, 1999), NMFS noted that whale watch vessel operators seek out areas where whales concentrate, which has led to numbers of vessels congregating around groups of whales, increasing the potential for harassment, injury, or even the death of these animals. Within the St. Lawrence Estuary, blue whales are believed to be affected by large amounts of recreational and commercial vessel traffic. Blue whales in the St. Lawrence appeared more likely to react to these vessels when boats made fast, erratic approaches or sudden changes in direction or speed (Edds and Macfarlane 1987b).

Several studies have specifically examined the effects of whale watching on marine mammals, and investigators have observed a variety of short-term responses from animals, ranging from no apparent response to changes in vocalizations, duration of time spent at the surface, swimming speed, swimming angle or direction, respiration rate, dive time, feeding behavior, and social behavior (NMFS 2006a). Responses appear to be dependent on factors such as vessel proximity, speed, and direction, as well as the number of vessels in the vicinity (Au and Green. 2000; Corkeron 1995b; Erbe 2002c; Magalhaes et al. 2002b; Richter et al. 2003b; Scheidat et al. 2004b; Watkins 1986; Williams et al. 2002b; Williams et al. 2002c). Foote et al. (2004) reported that southern resident killer whale call duration in the presence of whale watching boats increased by 10-15% between 1989-1992 and 2001-2003 and suggested this indicated compensation for a noisier environment. Disturbance by whale watch vessels has also been noted to cause newborn calves to separate briefly from their mothers' sides, which leads to greater energy expenditures by the calves (NMFS 2006a). Although numerous short-term behavioral responses to whale watching vessels are documented, little information is available on whether long-term negative effects result from whale watching (NMFS 2006a).

5.2.18 **Vessel Strike**

Vessel strike is a significant concern for the recovery of listed whales and, to a lesser degree, sea turtles. Evidence suggests that all dead whales are not detected particularly in offshore waters, and some detected carcasses are never recovered while those that are recovered may be in advanced stages of decomposition that preclude a definitive cause of death determination (Glass et al., 2010). Therefore, mortality could be greater than what is documented. More humpback whales are killed in collisions with ships than any other whale species except fin whales (Jensen and Silber 2003). Of 123 humpback whales that stranded along the Atlantic coast of the U.S. between 1975 and 1996, 10 (8.1%) showed evidence of collisions with ships (Laist et al. 2001). Between 1999 and 2005, there were 18 reports of humpback whales being struck by vessels along the Atlantic coast of the U.S. and the Maritime Provinces of Canada (Cole et al. 2005c; Nelson et al. 2007c). Of these reports, 13 were confirmed as ship strikes and in seven cases, ship strike was determined to be the cause of death. The first estimate of population-level effects of entanglement were recently produced, with over 12% of the Gulf of Maine population of humpbacks acquiring new scars from entanglement interactions annually (Mattila and Rowles 2010). Of three sei whales that stranded along the U.S. Atlantic coast during 1975-1996, two showed evidence of collisions (Laist et al. 2001). Between 1999 and 2005, there were three reports of sei whales being struck by vessels along the U.S. Atlantic coast and Canada's Maritime Provinces (Cole et al. 2005c; Nelson et al. 2007c). Two of these ship strikes were reported as having resulted in death.

Ship strikes are the largest single contributor to North Atlantic right whale deaths, accounting for approximately 35% of all known mortalities, even though right whales should be able to hear the sound produced by vessels (Ketten 1998a; Knowlton and Kraus 2001a; Laist et al. 2001; Richardson et al. 1995a). Some information suggests right whales respond only within very close proximity to ships (Nowacek et al. 2004a). Various types and sizes of vessels have been involved in ship strikes with large whales, including container/cargo ships/freighters, tankers, steamships, U.S. Coast Guard vessels, Navy vessels, cruise ships, ferries, recreational vessels, fishing vessels, whale-watching vessels, and other vessels (Jensen and Silber 2004a). Injury is generally caused by the rotating propeller blades, but blunt injury from direct impact with the hull also occurs. There have been 18 reports of North Atlantic right whales being struck by vessels between 1999 and 2005 (Cole et al. 2005b; Nelson et al. 2007b). Of the 17 reports that NMFS could confirm, right whales were injured in two of the ship strikes and killed in nine.

Recent records show that from 2004-2008, there were 17 confirmed reports of North Atlantic right whales being struck with eight whales dying of their wounds and two additional right whales sustaining serious injuries (Glass et al. 2009). (2008 being the most recent years for which peer-reviewed mortality counts are available) (Glass *et al*., 2010; Waring *et al*., 2010) Deaths of females are especially deleterious to the ability of the North Atlantic right whale population to recover. For instance, in 2005, mortalities included six adult females, three of which were carrying near-term fetuses and four of which were just starting to bear calves, thereby representing a lost reproductive potential of as many as 21 individuals over the short term (Kraus et al. 2005). Between 1999 and 2006, ships are confirmed to have struck 22 North Atlantic right whales, killing 13 of these whales (Jensen and Silber 2003; Knowlton and Kraus 2001b; NMFS 2005c). From 1999 to 2003, an average of 2.6 right whales were killed per year from various types of anthropogenic factors, but mostly from ship-strike (Waring et al. 2010). From 2000 to 2004, this increased to 2.8 annually and increased again from 2001 to 2005 to an average of 3.2 right whales (Waring et al. 2010). The most recent estimate of anthropogenic mortality and serious injury available showed a rate of 3.8 right whales per year from 2002 to 2006. Of these, 2.4 were attributed to ship strikes (Glass et al. 2008). Based on records collected between 1970 and 1999, about 60% of the right whales struck by ships along the Atlantic Coast of the United States, 20% occurred in waters off the northeast states and 20% occurred in waters off the mid-Atlantic or southeast states (Knowlton and Kraus 2001b). Over the same time interval (1970 to 1999), these authors identified 25 (45%) unconfirmed serious injuries and mortalities from ship strikes and 31 (55%) from entanglements in fishing gear. Of these, 19 were fatal interactions (16 ship strikes, three entanglements); 10 possibly fatal (two ship strikes, eight entanglements); and 27 nonfatal (seven ship strikes, 20 entanglements). Based on these confirmed mortalities, ships are responsible for more than one-third (16 out of 45, or 36%) of all confirmed right whale mortalities (a confirmed mortality is one observed under specific conditions defined by NMFS) [7]. Of the current threats to North Atlantic right whales, entanglement in commercial fishing gear and ship strikes pose the greatest threats. Part of the susceptibility of this species to ship strike may be its propensity to remain just below the surface, invisible to vessels, but at significant risk to ship strike (Parks et al. 2011b).

Another study conducted over a similar period – 1970 to 2002 – examined 30 (18 adults and juveniles, and 12 calves) out of 54 reported right whale mortalities from Florida to Canada (Moore et al. 2005). Human interaction (ship strike or gear entanglement) was evident in 14 of the 18 adults examined, and trauma, presumably from vessel collision, was apparent in 10 out of the 14 cases. Trauma was also present in four of the 12 calves examined, although the cause of

7 There are four main criteria used to determine whether serious injury or mortality resulted from ship strikes: (1) propeller cut(s), (2)pre-mortem bone-breakage, (3) haemorrhaging, and (4) poor health.
Knowlton, A. R., and S. D. Kraus. 2001b. Mortality and serious injury of northern right whales (Eubalaena glacialis) in the western North Atlantic Ocean. Journal of Cetacean Research and Management Special Issue 2:193-208.

death was more difficult to determine in these cases. In 14 cases, the assumed cause of death was vessel collision; an additional four deaths were attributed to entanglement. In the remaining 12 cases, the cause of death was undetermined (Moore et al. 2005).

New rules for seasonal (June through December) slowing of vessel traffic to 10 knots and changing shipping lanes by less than one nautical mile to avoid the greatest concentrations of right whales are expected to reduce the chance of humpback whales being hit by ships by 9%, fin whales by 42%, right whales by 62%, and sei whales by 17%; the same rule applies from November through April from Brunswick, Georgia to Jacksonville, Florida, where North Atlantic right whales go for calving and breeding. Speed rules also apply to medium and large ports along the eastern seaboard during this time frame when right whales migrate to and from northern feeding and southern breeding areas. Nearly a dozen shipping lanes transect through coastal waters of the southeastern US from the North-South Carolina to Cape Canaveral, Florida.

An update (unpublished data 1995–2011) ship strike inventory for the eastern seaboard indicates the following percentage of strikes by species: North Atlantic right whale (19%), humpback whale (28%), sei whale (6%), fin whale (17%), sperm whale (2%), and unknown species (16%). Based on the records available, large whales have been struck by ships off almost every coastal state in the United States, although ship strikes are most common along the Atlantic Coast. More than half (56%) of the recorded ship strikes from 1975-2002 occurred off the coasts of the northeastern United States and Canada, while the mid- Atlantic and southeastern areas each accounted for 22% (Jensen and Silber 2003).

The magnitude of the risks commercial ship traffic pose to large whales in the proposed action areas has been difficult to quantify or estimate. We struggle to estimate the number of whales that are killed or seriously injured in ship strikes within the US EEZ and have virtually no information on interactions between ships and commercial vessels outside of US waters. With the information available, we know those interactions occur but we cannot estimate their significance to whale species.

Ship strikes are a poorly-studied threat to sea turtles, but have the potential to be highly significant (Work et al. 2010b). All sea turtles must surface to breath and several species are known to bask at the surface for long periods, including loggerhead sea turtles. Although sea turtles can move rapidly, sea turtles apparently are not well able to move out of the way of vessels moving at more than 4 km/hr; most vessels move far faster than this in open water (Hazel and Gyuris 2006; Hazel et al. 2007; Work et al. 2010b). This, combined with the massive level of vessel traffic in the Gulf of Mexico, has the potential to result in frequent injury and mortality to sea turtles in the region (MMS 2007b). Hazel et al. (2007) suggested that green sea turtles may use auditory cues to react to approaching vessels rather than visual cues, making them more susceptible to strike as vessel speed increases. Each state along the Gulf of Mexico has several hundred thousand recreational vessels registered, including Florida with nearly one million-the highest number of registered boats in the United States-and Texas with over 600,000- ranked sixth nationally (NMMA 2007; USCG 2003; USCG 2005). Commercial vessel operations are also extensive. Vessels servicing the offshore oil and gas industry are estimated to make 115,675-147,175 trips annually, apart from commercial vessels travelling to and from some of the largest ports in the United States (such as New Orleans and Houston)(MMS 2007a; USN 2008). Extensive shrimping and other fishery effort is also expended in the area. Overall, ship strike is likely highly underestimated as a source of injury or mortality to sea turtles in the action area.

Atlantic sturgeon are also susceptible to vessel collisions. Out of a total of 28 mortalities reported in the Delaware estuary between 2005 and 2008, 14 resulted from vessel strike (Brown and Murphy 2007). Based on the demersal behavior demonstrated by Atlantic sturgeon, the damage inflicted upon carcasses and the large numbers of deep draft vessels, the authors concluded that interactions with large vessels such as tankers comprised the majority of the vessel strikes. Further, the authors determined that a mortality rate of more than 2.5% of the females within a population could result in population declines. Similarly, in the James River in Virginia, 34 out of a total of 39 Atlantic sturgeon had injuries consistent with vessel strikes (Brown and Murphy 2007, Balazik et al 2012). The actual number of vessel strikes in both of these river systems in unknown, however, Balazik et al (2012) estimated up to 80 sturgeon were killed between 2007 and 2010.

5.2.19 **Invasive Species**

Invasive species have been referred to as one of the top four threats to the world's oceans consistently ranked behind habitat degradation and alteration (Pughiuc 2010; Raaymakers 2003; Raaymakers and Hilliard 2002; Terdalkar et al. 2005; Wambiji et al. 2007). In most cases, habitat is directly affected by human alterations, as identified in the baseline section, such as hydromodification, mining, dredging, drilling, and construction. However, invasive species, facilitated by human commerce, have the ability to directly alter ecosystems upon which listed species rely.

Invasive species are a major threat to many ESA-listed species. For species listed by the USFWS, 26% were listed partially because of the impacts of invasive species and 7% were listed because invasive species were the major cause of listing (Anttila et al. 1998). Pimentel et al. (2004) found that roughly 40% of listed species are at risk of becoming endangered or extinct completely or in part due to invasive species, while Wilcove et al. (1998) found this to be 49%, with 27% of invertebrates, 37% of reptiles, 53% of fishes, and 57% of plants imperiled partly or wholly due to non-native invasions. In some regions of the world, up to 80% of species facing extinction are threatened by invasive species (Pimentel et al. 2004; Yan et al. 2002). Clavero and Garcia-Bertro (2005) found that invasive species were a contributing cause to over half of the extinct species in the IUCN database; invasive species were the only cited cause in 20% of those cases. Richter et al. (1997) identified invasive species as one of three top threats to threatened and endangered freshwater species in the U.S. as a whole.

5.2.19.1 ***Diseases***

The impacts of introduced pathogens in the aquatic environment has been poorly explored and we likely know very little about the true frequency and significance of pathogen invasions (Drake et al. 2001). Pathogens have adverse effects to invertebrate communities. Molluscs such as black and white abalone seem to be particularly sensitive to pathogens. Various species of the genus Vibrio, known to cause cholera in humans, white pox and white plague type II diseases in corals, and mortality in abalone of the same genus as black and white abalone, have been identified in ports and ballast water of vessels (Aguirremacedo et al. 2008; Anguiano-Beltrán et al. 1998; Ben-Haim and Rosenberg 2002). Oyster species have sustained several outbreaks from invasive pathogens, including Haplosporidium nelsoni (the cause of MSX disease, which Chesapeake Bay eastern oysters have shown 75-92% mortality to) and Perkinsus marinus (the cause of Dermo disease) in California, eastern North America, and Europe (Andrews 1984; Burreson and Ford 2004; Burreson et al. 2000; Ford and Haskin 1982; Renault et al. 2000), Bonamia ostreae in Europe (Ciguarria and Elston 1997; Van Banning 1987), and in the northeastern US, respectively (Ford 1996).

5.2.19.2 *Habitat Impacts*

In general, species located higher within a food web (including most ESA-listed species under NMFS' jurisdiction) are more likely to become extinct as a result of an invasion; conversely, species that are more centrally or bottom-oriented within a food web are more likely to establish (Byrnes et al. 2007; Harvey and May 1997). Propagule pressure is generally the reason for this trend, as individuals lower in the food web tend to have higher fecundity and lower survival rates (r-selection). This unbalancing of food webs makes subsequent introductions more likely as resource utilization shifts, increasing resource availability, and exploitation success by non-native species (Barko and Smart 1981; Byrnes et al. 2007). Such shifts in the base of food webs fundamentally alters predator-prey dynamics up and across food chains (Moncheva and Kamburska 2002). The number of extinction events seems to be roughly correlated with the number of invasive establishments within an area (Harvey and May 1997).

Pathogens and species with toxic effects not only have direct effects to listed species, but also may affect PCEs of critical habitat or indirectly affect the species through ecosystem-mediated impacts. There are a number of non-native species that have the potential to either expel toxins at low levels, only becoming problematic for other members of the ecosystem if their population grows to very large sizes, resulting in very large amounts of toxins being released. In other cases, pathogens are introduced to an environment affecting organisms in the environment that would directly affect critical habitat PCEs or indirectly affect listed species. Pathogens are in some cases very specific to hosts, but when a species similar to a listed species is introduced, eventually that parasite that specific to the non-native species can shift to also affecting similar native populations. In these cases, the effects may be directly adverse to listed species or indirect to food resources as identified in a species' critical habitat. And in other cases, parasites can have direct effects to PCEs of designated critical habitat or indirectly affect listed species.

Red tide dinoflagellates have been introduced via ballast water discharges and have the potential to undergo extreme seasonal population fluctuations. During bloom conditions, high levels of neurotoxins are released into local and regional surface water and air that can cause illness and death in fishes, sea turtles, marine mammals, and invertebrates (as well as their larvae) (Hallegraeff and Bolch 1992; Hallegraeff 1998; Hamer et al. 2001; Hamer et al. 2000; Lilly et al. 2002; McMinn et al. 1997). The brown alga, Aureococcus anophagefferens, causes brown tide when it blooms, causing diebacks of eelgrass habitat due to blooms decreasing light availability and failure of scallops and mussels to recruit (Doblin et al. 2004).

There are a few examples of indirect predatory effects caused by invasive species. European green crabs have invaded both the east and west Coasts of the U.S., having trophic scale effects to both environments. In Massachusetts Bay, green crabs prey upon native mussels and oysters, altering community structure (Grosholz 2002; Lafferty and Kuris 1996; Pimentel et al. 2004). The suppression of these native invertebrates led to increases in their natural prey; however, organisms at higher trophic levels did not increase in response to the green crabs.

The most commonly reported impact of non-native species in the freshwater and coastal environment is competition for limited resources (Nyberg 2007). Molluscs, decapods, and aquatic plants as taxonomic groups tend to be especially capable invaders and have proven to be disruptive to food webs. The most common impacts are alteration of habitat and nutrient availability as well as altering species composition and diversity within an ecosystem (Strayer 2010). Crabs, polychaetes, and mussels can increase bioturbation and aerate the sediment (Nyberg 2007). Gastropods can alter the biogeochemical cycle through excretion of biogenic silicate in the faeces and pseudofaeces (Ragueneau et al. 2005). Molluscan invasions can also provide substrate for epibionts, shelter for benthic species, remove nutrients from the water, decrease turbidity and increase light penetration, remove sediments, and promote phytoplankton blooms by releasing nutrients from sediments (Bertness 1984; Gutierrez et al. 2003; Hecky et al. 2004).

There are many examples of invertebrate competition either indirectly affecting similar species to listed species under NMFS jurisdiction or directly affecting the habitat they rely on. The compound tunicate, Botrylloides sandiegensis, was released near Woods Hole, Massachussetts and has outcompeted other encrusting organism in the coastal environment of southern New England (Lafferty and Kuris 1996). The invasive green mussel Perna viridis may competitively displace the native scorched mussel Brachidontes exustus through its greater growth rate and maximum size in Tampa Bay (Ranwell 1964).

Invasive plants can cause widespread habitat alteration, including native plant displacement, changes in benthic and pelagic animal communities, altered sediment deposition, altered sediment characteristics, and shifts in chemical processes such as nutrient cycling (Grout et al. 1997; Ruiz et al. 1999; Wigand et al. 1997). Introduced seaweeds alter habitat by colonizing previously unvegetated areas, while algae form extensive mats that exclude most native taxa, dramatically reducing habitat complexity and the ecosystem services provided by it (Wallentinus and Nyberg 2007). Invasive algae can alter native habitats through a variety of impacts, including trapping sediment, reducing the number of suspended particles that reach the benthos for benthic suspension and deposit feeders, reduce light availability, and adversely impact foraging for a variety of animals (Britton-Simmons 2004; Gribsholt and Kristensen 2002; Levi and Francour 2004; Sanchez et al. 2005). Invasive fishes can compose a large portion of fish taxa in at least some areas, including New Zealand where 53% of fish taxa are exotic, Puerto Rico where invasive fish are 91% of the total species, and Brazil where they are 13% of the total (Lövei 1997).

The spiny water flea causes extensive ecosystem disruption (Grout et al. 1997; Johannsson et al. 1991; Kerfoot et al. 2011). Bythotrephes is an important contributor to its native habitat, including as prey to salmon; however, in the Great Lakes, they reduce the fitness of many fish that are prey to salmonids (Hessen et al. 2011). Bythotrephes preys heavily upon plankton species, severely reducing not only their abundance, but has also caused their diversity to decline by roughly 20% (Foster and Sprules 2009; Kerfoot et al. 2011; Rennie et al. 2011). As a result, rotifers decline because of reduced diatom food resources and phytoplankton increase because Bythotrephes feeds on their competitors (Beisner et al. 2006; Kerfoot et al. 2011). Further tertiary effects include elevation of contaminant levels in higher-level predators due to extensions in the food web that allow for additional contaminants to accumulate in the underlying prey base (Kerfoot et al. 2011; Rennie et al. 2011). Other macroinvertebrate predators and fishes are also likely adversely impacted by this disruption of their prey base, with less prey available to them (Foster and Sprules 2009; Parker Stetter et al. 2005). These alterations to ecosystem food webs appear to be stable and persistent (Yan et al. 2008). Through these mechanisms, Bythotrephes alone represents a significant threat to the biodiversity within temperate North American aquatic environments (Grout et al. 1997).

Other invertebrates can also have major impacts on the ecosystems they invade. The introduced periwinkle, Littorina littorea, ranging along the Atlantic Coast from Canada to the mid-Atlantic, is highly-influential in the sedimentation process; because individuals cumulatively engage in so much grazing, some bottom habitats have become dominated by hard-bottom instead of soft bottom as they formerly were (Bertness 1984; Carlton 1999; Wallentinus and Nyberg 2007). Significant declines in soft-sediment habitats and fringing salt marshes are attributed at least partially to the invasion of this species, possibly due to consumption of marsh grasses, such as S. alterniflora (Bertness 1984). Species normally adapted to living in soft-bottom systems are gradually replaced by species better adapted for hard-bottom substrates.

A comprehensive review of the impacts of invasive species to the Chesapeake Bay was conducted by Ruiz et al. (1999). With at least 196 established non-native populations in the Chesapeake Bay, it is surprising that most of the impacts of invasive species on the Chesapeake Bay are generally undocumented. The authors found that 20% of the 196 documented invasive species had significant ecological impacts, while most of the other invasive species had not been studied for their impacts. Of the 39 species with significant ecological impacts, 69% did so through competition with native species, 38% altered habitat, 44% served as prey, 15% were predators of native species, 21% engaged in extensive herbivory, 8% produced hybrids with native taxa, and 8% were parasitic (Ruiz et al. 1999). Plants and fish were the largest taxonomic groups represented in the known invasive species of the Chesapeake Bay, representing 23% and 18% of the invasive species by taxa, respectively.

In this case study, while the invasive species have not been well studied, it appears the best documentation of effects may be indirect to sturgeon or sea turtles via alteration of food web dynamics and food availability. Two protistan pathogens, *Haplosporidium nelsoni* and Perkinsus marinus, are significant contributors to a 90% reduction in oyster abundance in the Chesapeake Bay over the past century, causing secondary effects such as reduced oyster reef habitat and altered food webs (Ruiz et al. 1999). The rapa whelk is now an abundant predator of native clams and oysters in the Bay (Deacutis and Ribb 2002) with similar ecological impacts to the protist pathogens. Mud crabs have also declined as a result of the invasive parasitic barnacles, Loxothylacus panopaei, which causes reproductive failure in the host (Hines et al. 1997; Ruiz et al. 1999; Van Engel et al. 1966). The Asiatic clam is so abundant in the Potomac River that it is estimated this species alone can filter the total phytoplankton biomass in three to four days and can constitute 90% or more of the bivalve biomass in some areas. Such efficient conversion of energy from the pelagic to the benthic environment likely benefits shortnose sturgeon by increasing worms and chironomids, two of their prey items. As a result of this invasion, between 1981 and 1993, water clarity tripled, subsequently increasing aquatic vegetation 50%, and ultimately increasing abundance of fish populations, slowing currents, increasing sedimentation, as well as altering benthic community composition and sediment characteristics through its large production of pseudofeces (Cohen et al. 1984; Phelps 1994; Ruiz et al. 1999). The reed, Phragmites auatralis, also outcompetes local plants and has become widespread and dominant within the Chesapeake Bay, altering habitat parameters and animal abundances (Marks et al. 1994; Ruiz et al. 1999). Typha angustifolia has similar impacts, outcompeting local species, reducing flow rates, increasing sedimentation, and altering sediment chemistry (Ruiz et al. 1999). Two invasive aquatic plants, *Hydrilla verticillata* and *Myriophyllum spicatum*, have received significant attention in the Chesapeake Bay. They form dense mats, alter aquatic chemical and habitat characteristics, fish and invertebrate communities, compete with native plants, and change the food base available for local waterfowl and fishes (Ruiz et al. 1999). Also noteworthy is that the cover provided by *Hydrilla* spp. provides additional refuge for smaller fishes, which can increase the populations of larger predatory species (Killgore et al. 1989; Ruiz et al. 1999). Trapa natans, a floating plant, at one time also outcompeted native plant species to the detriment of fishes and waterfowl, but has not recovered from an eradication program in the 1930s (Ruiz et al. 1999).

5.2.20 **Scientific Research and Permits**

Scientific research permits issued by the NMFS currently authorize studies of listed species in the Atlantic Ocean which occur primarily in the action area. Table 52 identifies the cumulative number of takes for each listed marine mammal and sea turtle species, as well as smalltooth sawfish, and sturgeon in the action area authorized in scientific research permits. Cetacean takes include approach, biopsy, suction cup and implantable tagging, breath sampling, acoustic playbacks, and/or ultrasound. Sea turtle research involves approach, capture, handling, restraint, PIT, flipper, satellite, or sonic tagging, lavage, mortality, ultrasound, blood or tissue sampling, captive experiments, laproscopy, imaging, and/or antibiotic injections. Smalltooth sawfish may be captured via a variety of means, measured, tagged, tissue sampled, and/or ultrasounded. Research actions on sturgeon species include capture, handling, restraint, anaesthesia, laproscopy, lavage, boroscopy, fin, operculum, or barbel clipping, PIT, floy, sonic, or satellite tagging, gonad sampling, prophylactic, and/or mortality.

Table 52. Authorized takes of non-salmonid listed species in the action area under the ESA and/or MMPA.

Species-North Atlantic populations or DPSs	**2009-2014 lethal take (juvenile to adult)**	**2009-2014 lethal take (larvae or egg)**	**2009-2014 sub-lethal take**
Blue whale	0	0	3,325
Fin whale	0	0	12,349

Sei whale	0	0	8,376
Humpback whale	0	0	47,250
North Atlantic right whale	0	0	37,880
Sperm whale	0	0	17,850
Green sea turtles	60	0	40,217
Hawksbill sea turtle	18	0	9,775
Kemp's ridley sea turtle	32	0	13,819
Leatherback sea turtle	11	0	8,519
Loggerhead sea turtle	420	0	40,048
Olive ridley sea turtle	6	0	1,298
Atlantic sturgeon	35	2,895	28,418
Shortnose sturgeon	161	35,821	41,261
Smalltooth sawfish	0	0	1,815

Permit numbers: 1420, 1447, 1449, 1450, 1462, 1475, 1486, 1501, 1505, 1506, 1507, 1516, 1518, 1522, 1526, 1527, 1538, 1540, 1542, 1544, 1547, 1549, 1551, 1552, 1556, 1557, 1570, 1571, 1575, 1576, 1578, 1580, 1595, 1599, 10014, 10022, 10037, 10115, 13306, 13307, 13330, 13543, 13544, 13573, 13927, 14118, 14176, 14233, 14245, 14249, 14272, 14394,14396, 14451, 14506, 14508, 14586, 14603, 14604, 14622, 14655, 14726, 14759, 14791, 14949, 15112, 15415, 15488, 15552, 15566, 15575, 15606, 15614, 15672, 15677, 15682, 15802, 16109, 16146, 16134, 16174, 16194, 16253, 16306, 16323, 16325, 16375, 16422, 16431, 16436, 16438, 16439, 16442, 16473, 16482, 16507, 16508, 16526, 16547, 16598, 17095, 17316, 594-1759, 605-1904, 633-1778, 775-1875, 909-1719, 948-1692, 981-1707, 1036-1744, 1058-1733, 1121-1900, and 1128-1922.

5.3 The Impact of the Baseline on Listed Resources

Listed resources are exposed to a wide variety of past and present state, Federal or private actions and other human activities that have already occurred or continue to occur in the action area. Federal projects in the action area that have already undergone formal or early section 7 consultation, and state or private actions that are contemporaneous with this consultation also impact listed resources. However, the impact of those activities on the status, trend, or the demographic processes of threatened and endangered species remains largely unknown.

5.3.1 Impact of the Baseline on Cetaceans

Historically, commercial whaling caused all of the large whales to decline to the point of extinction risk that were high enough to list them as endangered species. The major threat has ended with a widescale moratorium on commercial whaling. However, population sizes of endangered whales still remain at fractions of pre-whaling population sizes. Nevertheless, some populations like Western North Atlantic humpback whales have increased substantially from post-whaling populations levels and appear to be recovering despite ship strikes, interactions with fishing gear, and increased levels of ambient sound along the Atlantic coast. Blue, fin, sei, and sperm whales also exist at smaller population sizes as a result of the legacy of whaling in the Atlantic basin. We know considerably less about the potential effects of many of the stressors associated with the activities considered in this *Environmental Baseline* on growth rates, trend, or age-structure of populations comprising these species. For example, we do not yet know to what degree the U.S. and Canadian traffic separation schemes, or speed restrictions and vessel routing activities that NOAA has established along the Atlantic Coast of the U.S. reduces the number of North Atlantic right whales that are injured or killed during collisions with vessels. The Final Rule to reduce the severity and likelihood of vessel strikes to North Atlantic right whales went into effect on 9 December 2008 (73 FR 60173; 10 October 2008). The rule is set to expire five years from the date of its publication. NMFS indicated that it would develop ways to monitor the effectiveness of the rule. Therefore, NMFS committed to (a) developing means to monitor the rule's effectiveness, (b) assessing its overall effectiveness, and (c) preparing a report of the findings, which have been compiled as this report This is that report.

In reviewing studies regarding behavioral responses to human activities, including close approaches by ships, researchers have noted changes in respiration, diving, swimming speed, social exchanges, and other behavior correlated with the number, speed, direction, and proximity of vessels. Responses were different depending on the age, life stage, social status of the whales being observed (i.e., males, cows with calves) and context (feeding, migrating, etc.). Beale and Monaghan (2004a) concluded that the significance of disturbance was a function of the distance of humans to the animals, the number of humans making the close approach, and the frequency of the approaches. These results would suggest that the cumulative effects of the various human activities in the Action Area would be greater than the effects of the individual activity. Several investigators reported behavioral responses to close approaches that suggest that individual whales might experience stress responses. Baker *et al.* (1983)described two responses of whales to vessels, including: (1) "horizontal avoidance" of vessels 2,000 to 4,000 meters away characterized by faster swimming and fewer long dives; and (2) "vertical avoidance" of vessels from 0 to 2,000 meters away during which whales swam more slowly, but spent more time submerged. Watkins *et al.* (1981b) found that both fin and humpback whales appeared to react to vessel approach by increasing swim speed, exhibiting a startled reaction, and moving away from the vessel with strong fluke motions. Other researchers have noted changes in respiration, diving, swimming speed, social exchanges, and other behavior correlated with the number, speed, direction, and proximity of vessels. Results were different depending on the social status of the whales being observed (single males when compared with cows and calves), but humpback whales generally tried to avoid vessels when the vessels were 0.5 to 1.0 kilometer from the whale. Smaller pods of whales and pods with calves seemed more responsive to approaching vessels (Bauer 1986a; Bauer and Herman 1986b). These stimuli are probably stressful to the humpback whales in the Action Area, but the consequences of this stress on the individual whales remains unknown (Baker and Herman 1987; Baker et al. 1983). Studies of other baleen whales, specifically bowhead and gray whales, document similar patterns of behavioral disturbance in response to a variety of actual and simulated vessel activity and noise (Malme et al. 1983; Richardson et al. 1985c). For example, studies of bowhead whales revealed that these whales oriented themselves in relation to a vessel when the engine was on, and exhibited significant avoidance responses when the vessel's engine was turned on even at a distance of about 900 m (3,000 ft). Jahoda *et al.* (2003b) studied the response of 25 fin whales in feeding areas in the Ligurian Sea to close approaches by inflatable vessels and to biopsy samples. They concluded that close vessel approaches caused these whales to stop feeding and swim away from the approaching vessel. The whales also tended to reduce the time they spent at surface and increase their blow rates, suggesting an increase in metabolic rates that might indicate a stress response to the approach. In their study, whales that had been disturbed while feeding remained disturbed for hours after the exposure ended. They recommended keeping vessels more than 200 meters from whales and having approaching vessels move at low speeds to reduce visible reactions in these whales.

As we discussed in the *Status of the Species* section of this Opinion, the legacy effects of whaling appear to have had and continue to have greatest effect on endangered Northern Atlantic right whales by reducing them to a population size that is sufficiently small to experience "small population dynamics" (Caughley 1994; Lande et al. 2003; Melbourne and Hastings 2008) (Lande 1993). At its small population size, we would expect North Atlantic right whales to have higher probabilities of becoming extinct because of demographic stochasticity, demographic heterogeneity (Coulson et al. 2006) (Fox *et al.* 2006) —including stochastic sex determination (Lande et al. 2003) — and the effects of phenomena interacting with environmental variability. Demographic stochasticity refers to the randomness in the birth or death of an individual in a population, which results in random variation on how many young that individuals produce during their lifetime and when they die. Demographic heterogeneity refers to variation in lifetime reproductive success of individuals in a population (generally, the number of reproductive adults an individual produces over their reproductive lifespan), such that the deaths of different individuals have different effects on the growth or decline of a population (Coulson et al. 2006). Stochastic sex determination refers to the randomness in the sex of offspring such that sexual ratios in population fluctuate over time (Melbourne and Hastings 2008).

At small population sizes, populations experience higher extinction probabilities because of their population size, because stochastic sexual determination leaves them with all males or all females (which occurred to the heath hen and dusky seaside sparrow just before they became extinct), or because the loss of individuals with high reproductive success has a disproportionate effect on the rate at which the population declines (Coulson et al. 2006). North Atlantic right whales exist at population sizes sufficiently low to experience all or some of these forms of stochasticity and the evidence available suggests that the death of individual females disproportionately increases the rate at which the population declines. Based on the number of other species in similar circumstances that have become extinct (and the small number of species that have avoided extinction in similar circumstances), the longer North Atlantic right whales remain in these circumstances, the greater their extinction probability becomes.

North Atlantic right whale, fin, humpback, and sperm whales in the Action Area for this consultation, appear to be increasing in population size or, at least, their population sizes do not appear to be declining, despite their continued exposure to the direct and indirect effects of the activities discussed in the *Environmental Baseline*. North Atlantic right whale population growth rate reported for the period 1986-1992 by Knowlton et al. (1994) was 2.5% (CV=0.12), suggested that the stock was showing signs of slow recovery. Although we do not have information on other measures of the demographic status of these species (for example, age structure, gender ratios, or the distribution of reproductive success) that would facilitate a more robust assessment of the probable impact of the *Environmental Baseline,* we infer from their increasing abundance that the *Environmental Baseline,* which includes ongoing U.S. Navy training and testing, is not currently preventing their population size from increasing.

5.3.1.1 ***Anthropogenic Sound***

Recent attention has focused on the emergence of a wide number of anthropogenic sound sources in the action area and their role as a pollutant in the marine environment. Relationships between specific sound sources, or anthropogenic sound generally, and the responses of marine mammals to those sources are still subject to extensive scientific research and public inquiry but no clear patterns have emerged. As a result, the potential consequences of these activities on threatened and endangered marine mammals remain uncertain.

Gauthier and Sears (1999), Weinrich et al. (1991; 1992) Clapham and Mattila (1993), Clapham et al. (1993b) concluded that close approaches for biopsy samples or tagging caused humpback whales to respond or caused them to exhibit "minimal" responses when approaches were "slow and careful." This caveat is important and is based on studies conducted by Clapham and Mattila (1993) of the reactions of humpback whales to biopsy sampling in breeding areas in the Caribbean Sea. These investigators concluded that the way a vessel approaches a group of whales had a major influence on the whale's response to the approach; particularly cow and calf pairs. Based on their experiments with different approach strategies, they concluded that experienced, trained personnel approaching humpback whales slowly would result in fewer whales exhibiting responses that might indicate stress.

At the same time, several lines of evidence suggest that these human activities might result in greater consequences for individual whales (if not for whale populations). Several investigators reported behavioral responses to close approaches that suggest that individual whales might experience stress responses. Baker et al. (1983) described two responses of whales to vessels, including: (1) "horizontal avoidance" of vessels 2,000 to 4,000 meters away characterized by faster swimming and fewer long dives; and (2) "vertical avoidance" of vessels from 0 to 2,000 meters away during which whales swam more slowly, but spent more time submerged. Watkins et al. (1981a) found that both fin and humpback whales appeared to react to vessel approach by increasing swim speed, exhibiting a startled reaction, and moving away from the vessel with strong fluke motions.

Bauer (1986a) and Bauer and Herman (1986b) studied the potential consequences of vessel disturbance on humpback whales wintering off Hawai'i. They noted changes in respiration, diving, swimming speed, social exchanges, and other behavior correlated with the number, speed, direction, and proximity of vessels. Results were different depending on the social status of the whales being observed (single males when compared with cows and calves), but humpback whales generally tried to avoid vessels when the vessels were 0.5 to 1.0 kilometer from the whale. Smaller pods of whales and pods with calves seemed more responsive to approaching vessels.

Baker et al. (1983) and Baker and Herman (1987) summarized the response of humpback whales to vessels in their summering areas and reached conclusions similar to those reached by Bauer and Herman (1986b): these stimuli are probably stressful to the humpback whales in the action area, but the consequences of this stress on the individual whales remains unknown. Studies of other baleen whales, specifically bowhead and gray whales document similar patterns of short-term, behavioral disturbance in response to a variety of actual and simulated vessel activity and noise (Malme et al. 1983; Richardson et al. 1985b). For example, studies of bowhead whales revealed that these whales oriented themselves in relation to a vessel when the engine was on, and exhibited significant avoidance responses when the vessel's engine was turned on even at distance of approximately 900 m (3,000 ft). Weinrich er al. (1992) associated “moderate” and “strong” behavioral responses with alarm reactions and stress responses, respectively.

Jahoda et al. (2003a) studied the response of 25 fin whales in feeding areas in the Ligurian Sea to close approaches by inflatable vessels and to biopsy samples. They concluded that close vessel approaches caused these whales to stop feeding and swim away from the approaching vessel. The whales also tended to reduce the time they spent at surface and increase their blow rates, suggesting an increase in metabolic rates that might indicate a stress response to the approach. In their study, whales that had been disturbed while feeding remained disturbed for hours after the exposure ended. They recommended keeping vessels more than 200 meters from whales and having approaching vessels move a low speeds to reduce visible reactions in these whales.

Beale and Monaghan (2004b) concluded that the significance of disturbance was a function of the distance of humans to the animals, the number of humans making the close approach, and the frequency of the approaches. These results would suggest that the cumulative effects of the various human activities in the action area would be greater than the effects of the individual activity. None of the existing studies examined the potential effects of numerous close approaches on whales or gathered information of levels of stress-related hormones in blood samples that are more definitive indicators of stress (or its absence) in animals.

5.3.2 **Impact of the Baseline on Pinnipeds**

5.3.2.1 ***Ringed Seal – Arctic DPS***

According to the 2010, ringed seal status review (Kelly et al. 2010b), diminishing ice and snow cover are the greatest challenges to persistence of all of the ringed seal subspecies. Climate models consistently project overall diminishing ice and snow cover at least through the current century with regional variation in the timing and severity of those losses. Increasing atmospheric concentrations of GHGs, including carbon dioxide (CO_2), will drive climate warming and increase acidification of the ringed seal’s ocean and lake habitats. Acidification threatens changes in prey communities on which ringed seals depend.

Ice loss will be greatest in the summer and fall months when the ringed seal’s use of ice as a resting platform is at a minimum. In those months, however, ice remains important to prey populations such as Arctic cod, and ringed seal populations will be affected by diminished or geographically-shifted prey populations. Increased competition with northward-expanding, subarctic species may also affect prey densities. The greatest impacts to ringed seal reproduction may be from diminished ice cover mediated through diminished snow accumulation. While winter precipitation is forecasted to increase in a warming Arctic, the duration of ice cover will be substantially reduced, and the net affect will be lower snow accumulation on the ice. Model forecasts indicate that throughout the range of ringed seals, there will be substantial reductions in on-ice snow cover. Snow depth limits the formation of subnivean lairs, and birth lairs require depths of at least 50-65 cm. Such depths typically are found only where 20-30 cm or more of snow has accumulated on flat ice and drifted along pressure ridges or ice hummocks. Within the century, snow cover is forecasted to be inadequate for the formation and occupation of birth lairs over most of the species’ range. Without the protection of the lairs, ringed seals—especially newborn—are vulnerable to freezing and predation. As populations decline, the significance of currently low-level threats—including ocean acidification, increased human activity, and changes in populations of prey, predators, competitors, and parasites—may increase.

Subsistence and commercial harvests of Arctic ringed seals have been large in the past, but there is no evidence that they have contributed to large-scale population declines. Commercial harvests in the Sea of Okhotsk and predator-control harvests in the Baltic Sea, Lake Ladoga, and Lake Saimaa caused population declines in the past but have since been restricted. Current harvest levels appear to be low and sustainable. Recreational, scientific, and educational uses are minimal and not projected to increase significantly in the reasonably foreseeable future for any of the subspecies.

Ringed seals have co-evolved with numerous parasites and diseases, and those relationships are presumed to be stable. Evidence of distemper virus, for example, has been reported in Arctic ringed seals, but there is no evidence of impacts to ringed seal population size or productivity. Abiotic and biotic changes to ringed seals' habitat potentially could lead to exposure to new pathogens or new levels of virulence, but the BRT considered the potential threats to ringed seals as low.

Ringed seals are commonly preyed upon by polar bears and Arctic foxes, and less commonly by other terrestrial carnivores, sharks, and killer whales. Predation on newborn pups by gulls and ravens is typically prevented by the pups' concealment in subnivean lairs. When the pups are prematurely exposed, however, predation by birds—as well as terrestrial carnivores—can be substantial.

Reduced productivity in the Baltic Sea subspecies in recent decades resulted from pollutants impairing fertility. Petroleum development, commercial fisheries, increased ship traffic, and pollutants pose moderate risks to the Arctic, Okhotsk, and Baltic subspecies. Their significance would increase, however, for any populations diminished by the effects of climate change or other threats.

Climate change is potentially the most serious threat to ringed seal populations since much of their habitat depends on pack ice. Persistence of the Arctic subspecies of ringed seals likely will be challenged as decreases in ice and, especially, snow cover lead to increased juvenile mortality from premature weaning, hypothermia, and predation. The depth and duration of snow cover are forecasted to decline substantially throughout the range of Arctic ringed seals. Risks to abundance, productivity, spatial structure, and diversity currently are low. In the reasonably foreseeable future, however, it is expected that abundance and productivity will decline and spatial structure will be disrupted by rapid loss of habitat. Initially, impacts may be somewhat ameliorated if the subspecies' range retracts northward with sea-ice habitats. By 2100, however, average snow depths will fail to meet the 20-30 cm minimum needed for successful formation and maintenance of birth lairs in a substantial portion of the subspecies' range. Thus, within the reasonably foreseeable future, it is likely that the number of Arctic ringed seals will decline substantially, and they will no longer persist in substantial portions of their range.

5.3.3 Impact of the Baseline on Sea Turtles

Several of the activities described in this *Environmental Baseline* have significant and adverse consequences for nesting sea turtle aggregations whose individuals occur in the Action Area. In particular, the commercial fisheries annually capture substantial numbers of green, hawksbill, Kemp's ridley, leatherback, and Northwest Atlantic loggerhead sea turtles.

Although only small percentages of these sea turtles are estimated to have died as a result of their capture, the actual number could be substantial if considered over the past 5 – 10 years. When we add the percentage of sea turtles that have suffered injuries or handling stress sufficient to have caused them to delay the age at which they reach maturity or the frequency at which they return to nesting beaches, the consequences of these fisheries on nesting aggregations of sea turtles would be greater than we have estimated.

Even with TED measures in place, in 2002, NMFS (2002) expected these fisheries to capture about 323,600 sea turtles each year and kill about 5,600 (~1.7%) of the turtles captured. Loggerhead sea turtles account for most of this total: 163,000 captured, killing almost 4,000 (~2.5%) of them. Kemp's ridleys account for the second-most interactions: 155,503 captures with 4,200 (~2.7%) deaths. These are followed by green sea turtles: about 18,700 captured with more than 500 (~2.7%) dying as a result of capture. Leatherback sea turtle interactions were estimated at 3,090 captures with 80 (~2.6%) deaths as a result (NMFS 2002b). Since 2002, however, effort in the Atlantic shrimp fisheries has declined from a high of 25,320 trips in 2002 to approximately 13,464 trips in 2009., roughly 47% less effort. Since sea turtle takes are directly linked to fishery effort, these takes are expected to decrease proportionately. However, hundreds too a possible few thousand sea turtle interactions are expected annually, with hundreds of deaths (NMFS 2012).

Recent data regarding the three largest subpopulations that comprise the Northwest Atlantic loggerhead DPS indicated either that these subpopulations do not show a nesting decline significantly different from zero (Peninsular Florida and The Greater Caribbean subpopulation) or are showing possible signs of stability in nest numbers (Northern subpopulation). These trends were recently declining. Additional mortalities each year along with other impacts remain a threat to the survival and recovery of this species and could slow recovery green, Kemp's ridley, hawksbill, leatherback and Northwest Atlantic loggerhead sea turtles.

5.3.4 Impact of the Environmental Baseline on Fish

Several activities described in this *Environmental Baseline* have had significant and adverse consequences for Atlantic sturgeon, gulf sturgeon and smalltooth sawfish in the Action Area. While commercial fisheries for meat and caviar caused the initial decline for populations within the five DPSs of Atlantic sturgeon, habitat degradation, coastal runoff and river discharges carrying contaminates remain threats for Atlantic sturgeon and gulf sturgeon survival and recovery. Atlantic and gulf sturgeon are sensitive to pesticides, heavy metals, and other toxins in the aquatic and marine environment. Large sturgeon are most often killed by ship strikes although smaller fish often pass through the propellers without contact and injury. As shipping vessel size increases in the future, more Atlantic sturgeon are likely to be killed during encounters with ships.

We have been unable to estimate the sizes of the populations for any of the five Atlantic sturgeon DPSs; however, it is presumed that the Hudson and Altamaha rivers have the most robust of the remaining U.S. Atlantic sturgeon spawning populations and other U.S. spawning populations are likely less than 300 spawning adults per year (ASSRT 2007). At these small population sizes, however, increasing mortality rates or even maintaining current mortality rates is likely to be sufficient to slow recovery of Atlantic sturgeon populations.

6 Effects of the Action on Species and Critical Habitat

In *Effects of the Action* sections of this Opinion, we present results of our assessment of the probable direct and indirect effects of federal actions that are the subject of a consultation as well as the direct and indirect effects of interrelated, and interdependent actions on threatened and endangered species and designated critical habitat. As we described in the *Approach to the Assessment* section of this Opinion, we organize our effects' analyses using a stressor identification - exposure – response – risk assessment framework; we conclude this section with an *Integration and Synthesis of Effects* that integrates information we presented in the *Status of the Species* and *Environmental Baseline* sections of this Opinion with the results of our exposure and response analyses to estimate the probable risks the action poses to endangered and threatened species.

The following sections present the U.S. Navy's predicted impacts on ESA-listed species for annual and non-annual, training and testing activities. During the process of our ongoing adaptive management process and previous consultations, we have assessed the Navy's methodology in NAEMO and determined that the modeling data is the best available to assess potential exposure and response to U.S. Navy stressors associated with training and testing. Non-annual events, which may only take place a few times over the five-year period and do not reoccur every year, are considered separately in the exposure and response analysis because these impacts would not be assessed each year. However, potential take resulting from non-annual training and testing is totaled with any take from annual training and testing in our conclusions and in the incidental take statement of this opinion to provide the estimated, maximum take in a given year assuming all activities assessed are conducted in the given year.

6.1 Stressors Associated with the Proposed Action

The potential stressors (risks) to ESA-listed species that we analyzed based on the training and testing activities the U.S. Navy proposes to conduct in the AFTT Study Area are:

- The risk of disturbance from aircraft, surface vessels, underwater vehicles, torpedoes, targets, and seafloor devices;
- The risk of death or injury from collision (i.e., ship strike) with surface vessels, underwater vehicles, torpedoes, and targets;
- Risk of death or injury by entanglement or ingestion from by expendable materials and remnants of munitions;
- Risk of injury or disturbance from electromagnetic devices; and
- Risk of death, injury, or disturbance from acoustic sources such as active sonar, explosions, airguns, aircraft overflight and weapon firing.

What follows is a brief description of the stressors listed above. More information on each stressor is presented in the FEIS/OEIS. Following the descriptions, we present the results of our exposure analyses, followed by the results of our response analyses.

The following table lists the stressor categories that were assessed by the Navy in the FEIS/OEIS and NMFS in this opinion:

Table 53. U.S. Navy Stressor Categories Analyzed in This Opinion

Components and Stressors for Biological Resources	
Acoustic Stressors	• Sonar and other active sources • Explosives • Swimmer defense airguns • Weapons firing noise • Vessel noise • Aircraft noise
Energy Stressors	• Electromagnetic devices • High energy lasers
Physical Disturbance and Strike Stressors	• Vessels • In-water devices • Aircraft and aerial targets • Military expended materials • Seafloor devices
Entanglement Stressors	• Fiber optic cables and guidance wires • Parachutes
Ingestion Stressors	• Military expended materials from munitions • Military expended materials other than munitions
Secondary Stressors	• Habitat (sediment and water quality; air quality) • Prey

6.2 Risk Associated with Acoustic and Visual Stressors from Vessels and Aircraft

Studies have shown that vessels and aircraft presence and operation can result in changes in behavior of cetaceans (Arcangeli and Crosti 2009; Holt et al. 2009; Luksenburg and Parsons 2009; Noren et al. 2009; Patenaude et al. 2002; Richter et al. 2006; Richter et al. 2003a; Smultea et al. 2008). The combination of the physical presence of a surface vessel and the underwater noise generated by the vessel, or an interaction between the two may result in behavioral modifications of animals in the vicinity of the vessel or submarine (Goodwin and Cotton 2004; Lusseau 2006; Sims et al. 2012). Most studies are opportunistic and have only ascertained the short-term response to vessel sound and vessel traffic (Magalhaes et al. 2002a; Richardson et al. 1995e; Watkins 1981c); however, the long-term and cumulative implications of ship sound on marine mammals is largely unknown. Several authors suggest that the noise generated by the vessels is probably an important contributing factor to the responses of cetaceans to the vessels (Blane and Jaakson 1994; Evans et al. 1992; Evans et al. 1994).

Based on sea turtle sensory biology (Bartol et al. 1999a; Ketten and Bartol 2005; Ketten and Bartol 2006; Lenhardt et al. 1994; Ridgway et al. 1969), sound from low flying aircraft could be heard by a sea turtle at or near the surface. Turtles might also detect low flying aircraft via visual cues such as the aircraft's shadow. Hazel et al. (2007) suggested that green sea turtles rely more on visual cues than auditory cues when reacting to approaching water vessels. This suggests that sea turtles might not respond to aircraft overflights based on noise alone

Most of the activities the U.S. Navy proposes to conduct involve some level of activity from surface vessels or submarines. The presence and movement of these vehicles represent a potential source of disturbance for marine mammals; primarily in the form of sound production. The number of Navy vessels in the AFTT Study Area varies based on training and testing schedules. Most activities include either one or two vessels, with an average of one vessel per activity, and last from a few hours up to two weeks. Multiple ships, however, can be involved with major training events. Vessel movement and the use of in-water devices as part of the proposed action would be concentrated in portions of the Study Area, including the ports of Norfolk and training ranges. Vessels used as part of the Proposed Action include ships (e.g. aircraft carriers, surface combatants), support craft, and submarines ranging in size from 5 to over 300 meters. The U.S. Navy Fact Files on the World Wide Web (http://www.navy.mil/navydata/fact.asp) provide the latest information on the quantity and specifications of the vessels operated by the Navy.

Many of the activities the U.S. Navy proposes to conduct in the AFTT Study Area involve some level of activity from aircraft that include helicopters, maritime patrols, and fighter jets. Low-flying aircraft produce sounds that marine mammals can hear when they occur at or near the ocean's surface. Helicopters generally tend to produce sounds that can be heard at or below the ocean's surface more than fixed-wing aircraft of similar size and larger aircraft tend to be louder than smaller aircraft. Underwater sounds from aircraft are strongest just below the surface and directly under the aircraft. Sounds from aircraft would not have physical effects on marine mammals but represent acoustic stimuli (primarily low-frequency sounds from engines and rotors) that have been reported to affect the behavior of some marine mammals.

Numerous studies of interactions between surface vessels and marine mammals have demonstrated that free-ranging marine mammals engage in avoidance behavior when surface vessels move toward them. It is not clear whether these responses are caused by the physical presence of a surface vessel, the underwater noise generated by the vessel, or an interaction between the two (Amaral and Carlson 2005; Au and Perryman 1982b; Au and Green 2000a; Bain et al. 2006; Bauer 1986b; Bejder et al. 1999; Bejder and Lusseau. 2008; Bejder et al. 2009; Bryant et al. 1984; Corkeron 1995a; Erbe 2002c; Félix 2001; Goodwin and Cotton 2004; Lemon et al. 2006; Lusseau 2003a; Lusseau 2006; Magalhaes et al. 2002a; Nowacek et al. 2001; Richter et al. 2003a; Scheidat et al. 2004a; Simmonds 2005; Watkins 1986; Williams et al. 2002d; Wursig et al. 1998). However, several authors suggest that the noise generated during motion is probably an important factor (Blane and Jaakson 1994; Evans et al. 1992; Evans et al. 1994). These studies suggest that the behavioral responses of marine mammals to surface vessels are similar to their behavioral responses to predators.

Based on the suite of studies of cetacean behavior to vessel approaches (Acevedo 1991b; Aguilar Soto et al. 2006; Arcangeli and Crosti 2009; Au and Perryman 1982b; Au and Green 2000b; Bain et al. 2006; Bauer and Herman 1986a; Bejder et al. 1999; Bejder et al. 2006a; Bejder et al. 2006b; Bryant et al. 1984; Christiansen et al. 2010; Corkeron 1995a; David 2002; Erbe 2002c;

Felix 2001; Goodwin and Cotton 2004; Hewitt 1985; Lusseau 2003a; Lusseau 2006; Magalhaes et al. 2002a; Noren et al. 2009; Nowacek et al. 2001; Richter et al. 2006; Richter et al. 2003b; Scheidat et al. 2004a; Simmonds 2005; Stensland and Berggren 2007; Stockin et al. 2008; Watkins 1986; Williams and Ashe 2007; Williams et al. 2002d; Wursig et al. 1998), the set of variables that help determine whether marine mammals are likely to be disturbed by surface vessels include:

Number of vessels. The behavioral repertoire marine mammals have used to avoid interactions with surface vessels appears to depend on the number of vessels in their perceptual field (the area within which animals detect acoustic, visual, or other cues) and the animal's assessment of the risks associated with those vessels (the primary index of risk is probably vessel proximity relative to the animal's flight initiation distance) (Sims et al. 2012).

Below a threshold number of vessels (which probably varies from one species to another, although groups of marine mammals probably share sets of patterns), studies have shown that whales will attempt to avoid an interaction using horizontal avoidance behavior. Above that threshold, studies have shown that marine mammals will tend to avoid interactions using vertical avoidance behavior, although some marine mammals will combine horizontal avoidance behavior with vertical avoidance behavior (Bryant et al. 1984; David 2002; Kruse 1991; Lusseau 2003a; Nowacek et al. 2001; Stensland and Berggren 2007; Williams and Ashe 2007);

The distance between vessel and marine mammals when the animal perceives that an approach has started and during the course of the interaction (Au and Perryman 1982b; David 2002; Hewitt 1985; Kruse 1991; Lundquist et al. 2012; Lusseau 2003a; Tseng et al. 2011);

The vessel's speed and vector (David 2002);

The predictability of the vessel's path. That is, cetaceans are more likely to respond to approaching vessels when vessels stay on a single or predictable path (Acevedo 1991a; Angradi et al. 1993; Browning and Harland. 1999; Lusseau 2003a; Lusseau 2006; Williams et al. 2002a) than when it engages in frequent course changes (Evans et al. 1994; Lusseau 2006; Williams et al. 2002a);

Noise associated with the vessel (particularly engine noise) and the rate at which the engine noise increases (which the animal may treat as evidence of the vessel's speed) (David 2002; Lusseau 2003a; Lusseau 2006; Polagye et al. 2011);

The type of vessel (displacement versus planing), which marine mammals may interpret as evidence of a vessel's maneuverability (Goodwin and Cotton 2004);

The behavioral state of the marine mammals ((David 2002; Lusseau 2003a; Lusseau 2006; Wursig et al. 1998). For example, Würsig et al. (Wursig et al. 1998) concluded that whales were more likely to engage in avoidance responses when the whales were milling or resting than during other behavioral states.

Most of the investigations reported that animals tended to reduce their visibility at the water's surface and move horizontally away from the source of disturbance or adopt erratic swimming strategies (Corkeron 1995a; Lundquist et al. 2012; Lusseau 2003a; Lusseau 2004; Nowacek et al. 2001; Van Parijs and Corkeron 2001; Williams et al. 2002a; Williams et al. 2002d). In the process, their dive times increased, vocalizations and jumping were reduced (with the exception of beaked whales), individuals in groups move closer together, swimming speeds increased, and their direction of travel took them away from the source of disturbance (Baker and Herman 1989; Edds and Macfarlane 1987a; Evans et al. 1992; Kruse 1991). Some individuals also dove and remained motionless, waiting until the vessel moved past their location. Most animals finding themselves in confined spaces, such as shallow bays, during vessel approaches tended to move towards more open, deeper waters (Kruse 1991). We assume that this movement would give them greater opportunities to avoid or evade vessels as conditions warranted.

Although most of these studies focused on small cetaceans (for example, bottlenose dolphins, spinner dolphins, spotted dolphins, harbor porpoises, beluga whales, and killer whales), studies of large whales have reported similar results for fin and sperm whales (David 2002). Baker et al. (1983) reported that humpbacks in Hawaii responded to vessels at distances of 2 to 4 km. Richardson et al. (1985a) reported that bowhead whales (*Balaena mysticetus*) swam in the opposite direction of approaching seismic vessels at distances between 1 and 4 km and engage in evasive behavior at distances under 1 km. Fin whales also responded to vessels at a distance of about 1 km (Edds and Macfarlane 1987a). A study by Lundquist (2012) on dusky dolphins concluded that disturbance to tour vessel traffic may interrupt social interactions, and postulated that those disturbances may carry energetic costs, or otherwise affect individual fitness. However, they were unable to determine if such disturbances were likely to cause long-term harm.

Some cetaceans detect the approach of vessels at substantial distances. Finley et al. (1990) reported that beluga whales seemed aware of approaching vessels at distances of 85 km and began to avoid the approach at distances of 45-60 km. Au and Perryman (1982b) studied the behavioral responses of eight schools of spotted and spinner dolphins (*Stenella attenuata* and *S. longirostris*) to an approaching ship (the NOAA vessel Surveyor: 91.4 meters, steam-powered, moving at speeds between 11 and 13 knots) in the eastern Pacific Ocean (10°15 N lat., 109°10 W long.). They monitored the response of the dolphin schools to the vessel from a Bell 204 helicopter flying a track line ahead of the ship at an altitude of 366 – 549 meters (they also monitored the effect of the helicopter on dolphin movements and concluded that it had no observable effect on the behavior of the dolphin schools). All of the schools continuously adjusted their direction of swimming by small increments to continuously increase the distance between the school and the ship over time. The animals in the eight schools began to flee from the ship at distances ranging from 0.9 to 6.9 nm. When the ship turned toward a school, the individuals in the school increased their swimming speeds (for example, from 2.8 to 8.4 knots) and engaged in sharp changes in direction.

Hewitt (1985) reported that five of 15 schools of dolphin responded to the approach of one of two ships used in his study and none of four schools of dolphin responded to the approach of the second ship (the first ship was the NOAA vessel David Jordan Starr; the second ship was the

Surveyor). Spotted dolphin and spinner dolphins responded at distances between 0.5 to 2.5 nm and maintained distances of 0.5 to 2.0 nm from the ship while striped dolphins allowed much closer approaches. Lemon et al. (2006) reported that bottlenose dolphin began to avoid approaching vessels at distances of about 100 m.

Würsig et al. (1998) studied the behavior of cetaceans in the northern Gulf of Mexico in response to survey vessels and aircraft. They reported that Kogia species and beaked whales (ziphiids) showed the strongest avoidance reactions to approaching ships (avoidance reactions in 11 of 13 approaches) while spinner dolphins, Atlantic spotted dolphins, bottlenose dolphins, false killer whales, and killer whales either did not respond or approached the ship (most commonly to ride the bow). Four of 15 sperm whales avoided the ship while the remainder appeared to ignore its approach.

Pirotta et al. (2012a) used the U.S. Navy’s Atlantic Undersea Test and Evaluation Center (AUTEC) facility to investigate how vessel noise affects beaked whale behavior. They conducted an experiment involving the exposure of target whale groups to intense vessel-generated noise to test how these exposures influenced the foraging behavior of Blainville’s beaked whales in the Tongue of the Ocean (Bahamas). They found that the duration of foraging bouts was not significantly affected by exposure to vessel noise. Although changes in the hydrophone over which the group was most frequently detected occurred as the animals moved around within a foraging bout, and their number was significantly less the closer the whales were to the sound source. Non-exposed groups also had significantly more changes in the primary hydrophone than exposed groups irrespective of distance. They suggest that broadband ship noise caused a significant change in beaked whale behavior up to at least 5.2 kilometers away from the vessel.

Pirotta et al. (2012b) concluded that observed changes could potentially correspond to a restriction in the movement of groups, a period of more directional travel, a reduction in the number of individuals clicking within the group, or a response to changes in prey movement.

The study on dusky dolphins conducted by Lundquist et al. (2012) concluded that disturbance to tour vessel traffic may interrupt social interactions, but they were only able to postulated that those disturbances may carry energetic costs, or otherwise affect individual fitness. They were unable to determine if such disturbances were likely to cause long-term harm.

Much of the increase in ambient noise levels in the oceans over the last 50 years has been attributed to increased shipping, primarily due to the increase in the number and tonnage of ships throughout the world, as well as the growth and increasing interconnection of the global economy and trade between distant nations (NRC 2003). Commercial fishing vessels, cruise ships, transport boats, recreational boats, and aircraft, all contribute sound into the ocean (NRC 2003). Military vessels underway or involved in naval operations or exercises, also introduce anthropogenic noise into the marine environment.

Sounds emitted by large vessels can be characterized as low-frequency, continuous, or tonal, and sound pressure levels at a source will vary according to speed, burden, capacity and length (Richardson et al. 1995e). Vessels ranging from 135 to 337 meters (Nimitz-class aircraft carriers, for example, have lengths of about 332 meters) generate peak source sound levels from 169-200 dB between 8 Hz and 430 Hz. Given the sound propagation of low frequency sounds, a large vessel in this sound range can be heard 139-463 kilometers away (Ross 1976).

Most studies of whale interactions with vessels are opportunistic and have only examined the short-term response to vessel sound and vessel traffic (Magalhaes et al. 2002a; Noren et al. 2009; Richardson et al. 1995e; Watkins 1981d). The long-term and cumulative implications of ship sound on marine mammals are largely unknown {NOAA, 2012 #151110}. Clark et al. (Clark et al. 2009a) provided a discussion on calculating the cumulative impacts of anthropogenic noise on baleen whales and estimated that in some habitats with high rates of vessel traffic and high levels of vessel noise, the predicted area over which animals can communicate is routinely reduced to a small proportion (< 20 percent) of what it would be under quiet conditions (Clark et al. 2009a).

There are few studies of the responses of marine animals to air traffic and the few that are available have produced mixed results. Some investigators report some responses while others report no responses. Richardson et al. (1995e) reported that there is no evidence that single or occasional aircraft flying above large whales and pinnipeds in-water cause long-term displacement of these mammals. Several authors have reported that sperm whales did not react to fixed-wing aircraft or helicopters in some circumstances (Au and Perryman 1982a; Clarke 1956a; Green et al. 1992; Smultea et al. 2008) (Gambell 1968) and reacted in others (Mullin et al. 1991, Patenaude et al. 2006(Clarke 1956a; Fritts 1983; Richter et al. 2006; Richter et al. 2003a; Wursig et al. 1998). Richardson et al. (1985c)reported that bowhead whales responded behaviorally to fixed-wing aircraft that were used in their surveys and research studies when the aircraft were less than 457 meters above sea level; their reactions were uncommon at 457 meters, and were undetectable above 610 meters. They also reported that bowhead whales did not respond behaviorally to helicopter overflights at about 153 meters above sea level.

Smultea et al. (2008) studied the response of sperm whales to low-altitude (233-269 m) flights by a small fixed-wing airplane near Kauai and reviewed data available from other studies. They concluded that sperm whales responded behaviorally to aircraft passes in about 12 percent of encounters. All of the reactions consisted of sudden dives and occurred when the aircraft was less than 360 m from the whales (lateral distance). They concluded that the sperm whales had perceived the aircraft as a predatory stimulus and responded with defensive behavior. In at least one case, Smultea et al. (Smultea et al. 2008) reported that the sperm whales formed a semi-circular “fan” formation that was similar to defensive formations reported by other investigators.

In a review of aircraft noise effects on marine mammals, Luksenburg and Parsons (2009) determined that the sensitivity of whales and dolphins to aircraft noise may depend on the animals’ behavioral state at the time of exposure (e.g. resting, socializing, foraging or travelling) as well as the altitude and lateral distance of the aircraft to the animals. While resting animals seemed to be disturbed the most, low flying aircraft with close lateral distances over shallow water elicited stronger disturbance responses than higher flying aircraft with greater lateral distances over deeper water (Patenaude et al. 2002; Smultea et al. 2008).

6.2.1 Exposure of Species to Acoustic and Visual Stressors from Vessels and Aircraft

We did not estimate the number of endangered or threatened species that are likely to be exposed to vessels independent of the number of individual exposures to acoustic sources that might occur as the result of the training and testing activities in the AFTT Study Area. We assume that any individuals of the endangered or threatened marine mammals, fish and sea turtles that occur in the Action Area during the training and testing activities may be exposed to visual and acoustic stimuli associated with vessel traffic and related activities (see the Exposure to Acoustic Sources section below).

We did not estimate the number of endangered or threatened species that are likely to be exposed to aircraft traffic during take-offs and landings and at altitudes low enough for the sounds of their flight to be salient below the ocean's surface. Nevertheless, we assume that any individuals of the endangered or threatened species that occur in the Action Area during training and testing activities that involve aircraft are likely to be exposed to acoustic stimuli associated with aircraft traffic.

Many unit-level training exercises and testing activities do not involve aircraft traffic, involve less traffic when they involve traffic at all, have shorter duration, and affect much more localized areas than major exercises, so fewer endangered and threatened species would be exposed to aircraft traffic during these smaller activities.

6.2.2 Response of Species to Acoustic and Visual Stressors from Vessels and Aircraft

For surface vessels, the set of variables that help determine whether marine mammals are likely to be disturbed include: (1) the number of vessels in a marine mammal's perceptual field and the animal's assessment of the risks associated with those vessels; (2) the distance between vessels and marine mammals; (3) the vessel's speed and path; (4) the predictability of the vessel's path; (5) noise associated with the vessel and the rate at which the engine noise increases; (6) the type of vessel; and (7) the behavioral state of the animal. Because of the number of vessels involved in U.S. Navy training exercises and testing activities, the vessel speed, and the use of course changes as a tactical measure with the associated sounds, the available evidence leads us to expect marine mammals to treat Navy vessels as potential stressors. Further, without considering differences in sound fields associated with any active sonar that is used during these exercises, the available evidence suggests that major training exercises (for example, Composite Training Unit Exercise, Joint Task Force Exercise/Sustainment Exercise), unit- and intermediate-level exercises, and testing activities would represent different stress regimes because of differences in the number of vessels involved, vessel maneuvers, and vessel speeds.

We recognize that Navy vessels almost certainly incorporate quieting technologies that reduce their acoustic signature (relative to the acoustic signature of similarly-sized vessels) in order to reduce their vulnerability to detection by enemy vessels (Southall 2005). Nevertheless, we do not assume that any quieting technology would be sufficient to prevent marine mammals, fish or sea turtles from detecting sounds produced by approaching Navy vessels.

We considered the research and reports cited above and conclude that in general blue, fin, humpback, and sei whales are likely to either not react or exhibit an avoidance behavior. Most of these avoidance responses would consist of slow movements away from vessels the animals perceive are on an approaching course, perhaps accompanied by slightly longer dives (or longer intervals between blows). Most of the changes in behavior would consist of a shift from behavioral states that have low energy requirements (resting or milling) to behavioral states with higher energy requirements (active swimming or traveling). In some instances, the whales are either not likely to respond or are not likely to respond in ways that might be adverse to the whales (the responses might represent an approach or attentive movement, a small change in orientation in the waters, etc.).

Behavioral disruptions of whales result from the presence of vessels or submarines, those disruptions are expected to be temporary. Animals are expected to resume their migration, feeding, or other behaviors with minimal threat to their survival or reproduction. Marine mammals react to vessels in a variety of ways and seem to be generally influenced by the activity the marine mammal is engaged in when a vessel approaches (Richardson et al. 1995e). Some respond negatively by retreating or engaging in antagonistic responses while other animals ignore the stimulus altogether (Terhune and Verboom 1999; Watkins 1986).

We assume that humpback and sperm whales would respond to both any active sonar, and other mid-frequency and low-frequency acoustic cues produced by surface vessels involved in an exercise, and their perception of whether ships are approaching them or moving away when they decide whether or not to avoid the vessels.

With regard to pinnipeds, one study (Tripovich et al. 2012) reports the behavioural response of breeding Australian fur seals to motor boat noise. Using controlled noise exposure experiments we were able to quantify the response of seals to three sound intensities to determine a relatively safe received level of boat noise below 74 dB. The results suggest seals perceive boats as potential threats with louder motor boat noise having a greater impact on seals, where seals displayed more aggressive and alert behaviours. In the study, seals reacted more strongly to hearing the louder sounds by either orientating themselves towards the boat noise or physically moving away. Seals displayed significantly different responses between low (64–70 dB) and high levels (75–85 dB), indicating that in air, noise levels above 74 dB are predicted to cause behavioural disturbance in Australian fur seals. At high levels (75–85 dB), seals displayed energetically costly behaviours. During one of the playback experiments (high level), seals began to move rapidly away from the noise, displaying a cascading effect resembling those in the initial stages of a stampede.

Based on the information available, endangered and threatened sea turtles and fish are not likely to respond to visual or sound stressors from U.S. Navy vessels of any class that are at a distance and continue current behavior (feeding, swimming, breeding, etc.). Closer interactions with vessels and sea turtles may illicit normal avoidance behavior such as diving and fast swimming which may result in very short interruptions of feeding or other behavioral activities.

6.3 Risk of Injury or Mortality from Collision with Vessels

The movement of surface and subsurface vessels in waters that also might be occupied by endangered or threatened marine mammals, fish and sea turtles (although the risk of striking sea turtles or fishes is smaller than the risk of striking endangered marine mammals) pose collision or ship strike hazards to those species. Pinnipeds in general appear to suffer fewer impacts from ship strikes than do cetaceans. This may be due, at least in part, to the large amount of time they spend on land (especially when resting and breeding), and their high maneuverability in the water. Ship strikes are known to injure and kill sea turtles (Work et al. 2010a). Stranding networks that keep track of sea turtles that wash up dead or injured have consistently recorded vessel propeller strikes as a cause or possible cause of death (Chaloupka et al. 2008b).

Given the speeds at which these vessels are likely to move, they pose some risk of collisions between these ships and marine mammals or sea turtles (although the risks of striking sea turtles is smaller than the risks of striking endangered marine mammals). Large Navy ships generally operate at speeds in the range of 10 to 15 knots, and submarines generally operate at speeds in the range of 8 to 13 knots. Small craft (for purposes of this discussion, less than 40 ft. [12 m] in length), which are all support craft, have much more variable speeds (dependent on the mission). While these speeds are representative of most events, some vessels need to operate outside of these parameters. For example, to produce the required relative wind speed over the flight deck, an aircraft carrier vessel group engaged in flight operations must adjust its speed through the water accordingly. Conversely, there are other instances such as launch and recovery of a small rigid hull inflatable boat, vessel boarding, search, and seizure training events or retrieval of a target when vessels would be dead in the water or moving slowly ahead to maintain steerage. There are a few specific events including high speed tests of newly constructed vessels such as aircraft carriers, amphibious assault ships and the joint high speed vessel (which will operate at an average speed of 35 knots) where vessels would operate at higher speeds.

The term “vessel strike” indicates injury or mortality caused by entrainment through the propellers of vessels and direct collisions with vessel hulls. The Atlantic Sturgeon Status Review Team (2007) determined Atlantic sturgeon in the Delaware River are at a moderately high risk of extirpation in that system because of ship strikes and sturgeon in the James River are at a moderate risk from ship strikes. Since that time, managers in the Hudson River are concerned that ship strikes may also be threatening Atlantic sturgeon populations there. In these systems, large ships move upstream from the mouths of the river to ports upstream through narrow shipping channels. The channels are dredged to the approximate depth of the ships, usually leaving less than 6 feet of clearance between the bottom of ships and the benthos of the river. Because of the size of the propellers used on large ships, everything along the bottom is sucked through the propellers. Large sturgeon are most often killed by ship strikes because smaller fish often pass through the propellers without making contact but larger sturgeon get hit. As shipping increases in the future, as has been predicted by the US Coast Guard, more Atlantic sturgeon are likely to be killed during encounters with ships. Besides the threats to Atlantic sturgeon from ships, the act of dredging the channel can also kill sturgeon.

Between 2005 and 2008, a total of 28 Atlantic sturgeon mortalities were reported in the Delaware Estuary (Brown and Murphy 2010). Sixty-one percent of the mortalities reported were of adult size and 50 percent of the mortalities resulted from apparent vessel strikes. The remainder of the mortalities were too decomposed to ascertain the cause of death, but the majority were likely the result of vessel strikes. For small remnant populations of Atlantic sturgeon, such as that in the Delaware River, the loss of just a few individuals per year due to anthropogenic sources of mortality, such as vessel strikes, may continue to hamper restoration efforts. Brown and Murphy (2010) also concluded through an-egg-per-recruit analysis in the Delaware Estuary that vessel-strike mortalities could be detrimental to the population if more than 2.5 percent of the female sturgeon are killed annually.

The majority of vessel strikes appeared to result from interactions with large vessels, such as tankers, with a lower percentage likely resulting from interactions with small recreational or commercial fishing vessels equipped with outboard or inboard/outboard (stern drive) engines. Atlantic sturgeon are demersal fishes and thus if the sturgeon are spending most of their time at the bottom of the water column, then they are most likely being impacted by larger vessels. Large vessels that transit the shipping channel typically draft close to the bottom of the channel, thereby posing a threat to sturgeon positioned close to the bottom of the channel estuary (Brown and Murphy 2010). Alternatively, sturgeon are known to frequently jump out of the water (Sulak et al. 2002). During jumping episodes, when sturgeon are located at or near the surface of the water, they may be more vulnerable to strikes from smaller vessels powered by outboards.

The number of Navy vessels in the Study Area at any given time varies and is dependent on local training or testing requirements. Most activities include either one or two vessels and may last from a few hours up to two weeks. The primary threats to sturgeon exist in stretches of riverine systems where shipping channels are narrow and shallow. The primary systems discussed in this Opinion are the Hudson River, James River and Delaware River. Vessel movement as part of the Navy's proposed action would be widely dispersed throughout the Study Area, but more concentrated in portions of the Study Area near ports, naval installations, range complexes and testing ranges. See Figure 25. Relative U.S. Navy Vessel Traffic Density in the AFTT Study Area. Navy activities are not likely to occur in the Hudson River or Delaware River systems in areas where strike potential is greatest. While the U.S. Navy does maintain port operation and some training and logistical exercises in the James River, the vast majority of operations would take place in lower stretches of the River and open bay areas where sturgeon are less confined and shipping lanes are wider.

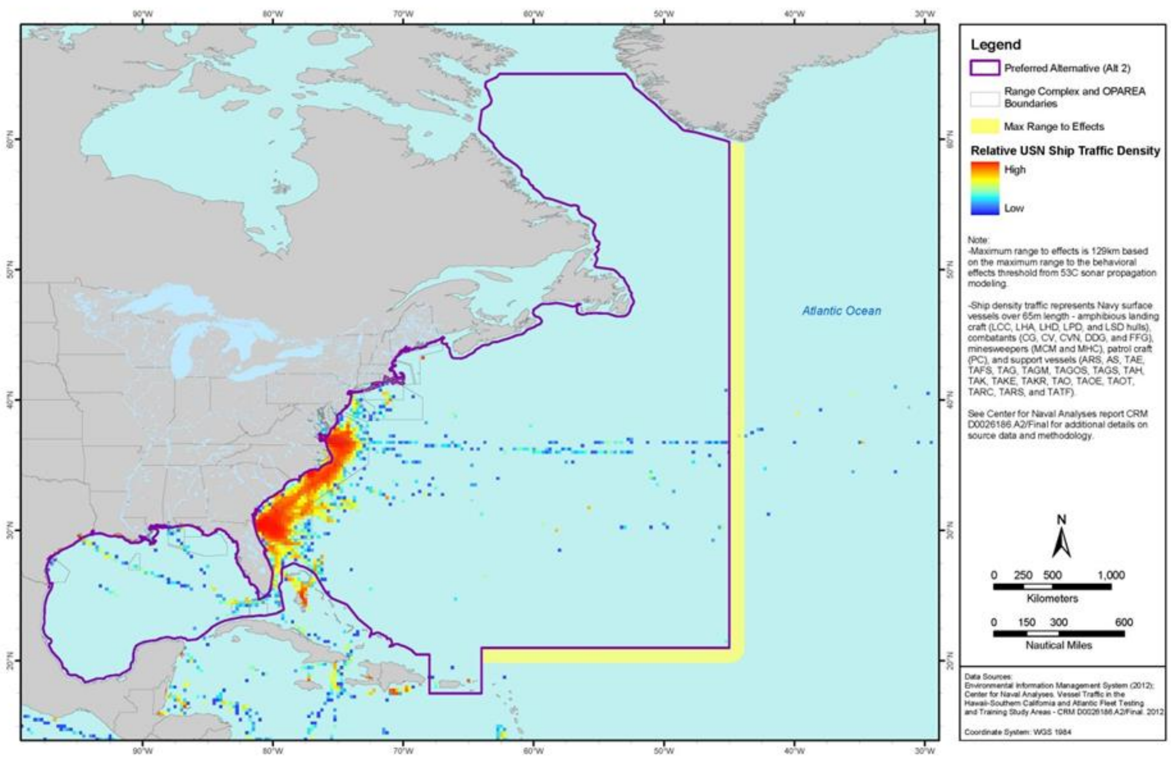

Figure 25. Relative U.S. Navy Vessel Traffic Density in the AFTT Study Area

In-water devices are unmanned vehicles, such as remotely operated vehicles, unmanned surface vehicles, unmanned undersea vehicles, and towed devices. These devices are self-propelled and unmanned or towed through the water from a variety of platforms, including helicopters and surface ships. In-water devices are generally smaller than most Navy vessels ranging from several inches to about 15 m.

These devices can operate anywhere from the water surface to the benthic zone. Certain devices do not have a realistic potential to strike living marine resources because they either move slowly through the water column (e.g. most unmanned undersurface vehicles) or are closely monitored by observers manning the towing platform (e.g. most towed devices).

We did not estimate the number of individual marine mammals or sea turtles that are likely to be exposed to vessels independent of the number of individual exposures (modeled by the Navy) to acoustic sources that might occur as the result of the training and testing activities in the AFTT Study Area. We did not quantify exposure of fish to these stressors. The table below indicates the number and location of events using a variety of vessels ranging from small inflatable boats to aircraft carriers in the AFTT Study Area. We assume that any individuals of the endangered or threatened marine mammals, fish and sea turtles that occur in the Action Area during the training and testing activities may be exposed to visual and acoustic stimuli associated with vessel traffic.

We did not estimate the number of endangered or threatened species that are likely to be exposed to aircraft traffic. Animals may be exposed during take-off and landings and at altitudes low enough for the sounds of their flight to be salient below the ocean's surface and also potentially at higher altitudes where supersonic flight occurs and/or where sea surface conditions promote penetration of sound below the surface. Nevertheless, we assume that any individuals of the endangered or threatened species that occur in the Action Area during training and testing activities that involve aircraft are likely to be exposed to acoustic stimuli associated with low-flying aircraft traffic such as helicopters and propeller and jet aircraft.

6.3.1 Exposure of Cetaceans to Collision with Vessels

To estimate the number of ESA-listed animals that would be exposed to the risk of vessel strike, the Navy conducted an analysis that is included in the FEIS/OEIS based on the history of ship strikes in the AFTT Study Area. In addition to this analysis, NMFS requested the Navy conduct an exposure analysis using the NAEMO software, if possible. The Navy indicated that the NAEMO was not the suitable tool to estimate potential for ship strike and relied on the historic ship strike data based based on real-world events to provide a more precise risk assessment.

The following table provides an overview of the number of training exercises and testing activities using vessels in a given year within the AFTT study area.

Table 54. Number and Location of Events Involving the Use of Vessels

Activity Area	Training Exercises	Testing Activities
NUWCDIVNPT	0	499
Northeast	470	459
VACAPES	10,210	859
Cherry Point	9,263	434
JAX	9,767	738
SFOMF	0	118
Key West	12	52
NSWC PCD	0	452
GOMEX	895	0
Gulf of Mexico	5	113
Other AFTT areas	363	0
AFTT Study Area	0	41
Total	**30,985**	**3,765**

Additionally, Figure 26 and Figure 27 below provide the relative composition of vessel use across training ranges and testing areas.

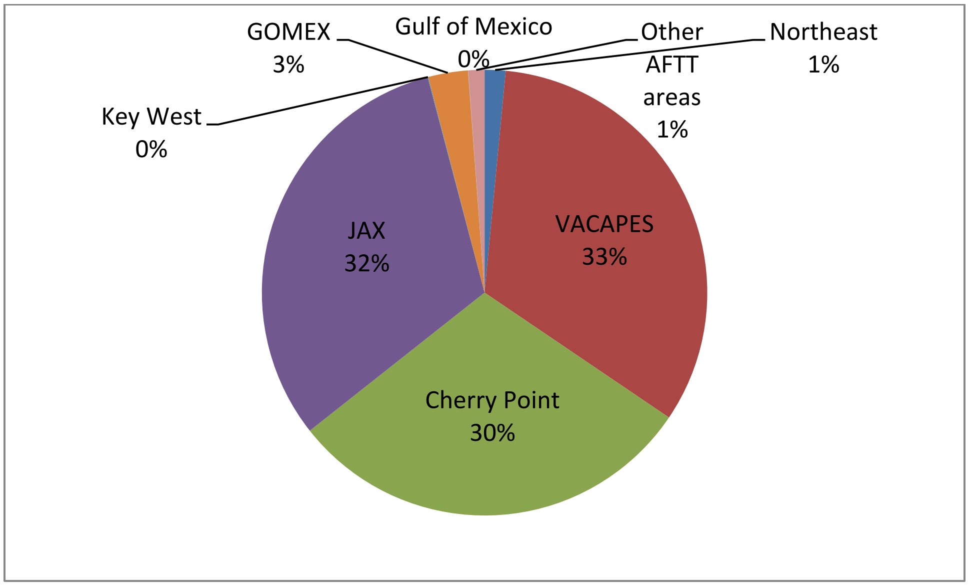

Figure 26.Vessel Use By Area for Training Exercises

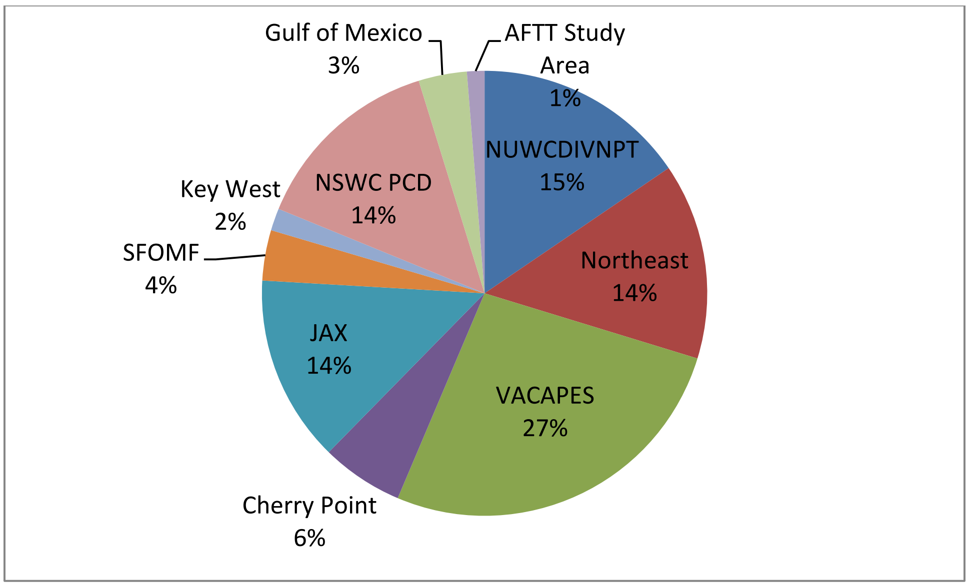

Figure 27.Vessel Use By Area for Testing Activities

Lastly, Figure 28, below provides a breakdown by year of vessel strikes reported annually from 1995 through 2012 by the U.S. Navy.

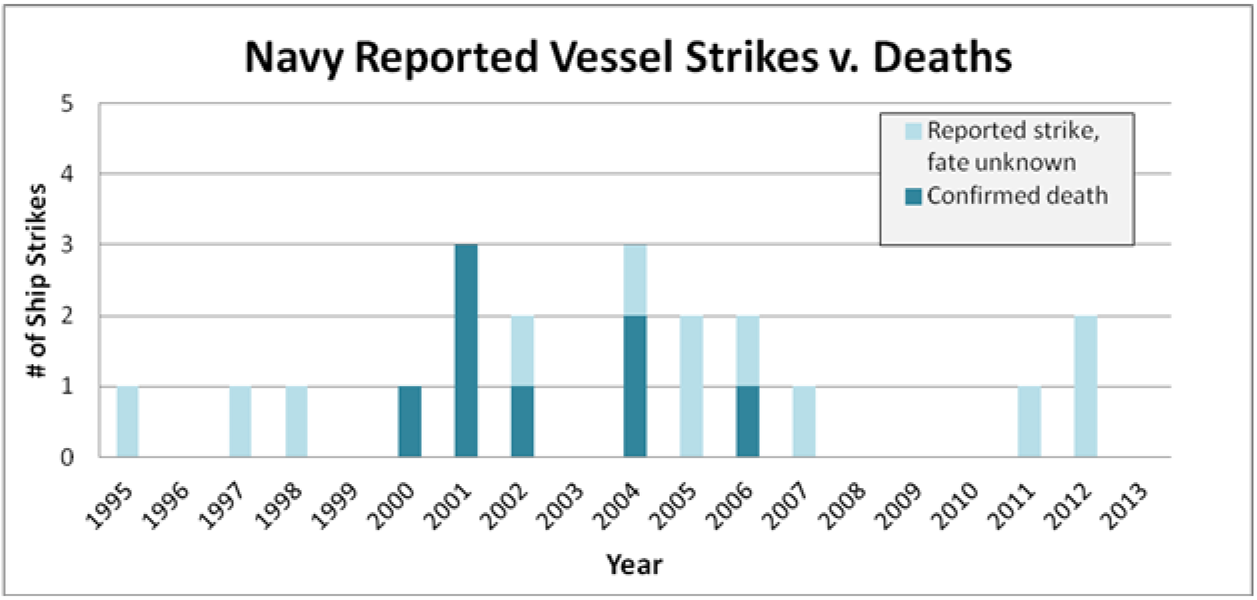

Figure 28. Navy Reported Vessel Strikes vs. Deaths (1995-2013)

The Navy estimated the number of potential vessel strikes by assessing the probability of hitting individuals of different species of large whales that occur in the AFTT Study Area. The Navy considered unpublished ship strike data (See figure above) compiled and provided by NMFS' Southwest Regional Office and Pacific Island Regional Office, unpublished Navy ship strike information collected by the Navy, and information on the trends in the amount of vessel traffic related to their training and testing activities in the AFTT Study Area. Specifics regarding this analysis is provided in the Navy's ESA consultation request package. Based on the Navy's analysis, they estimated that naval vessels could potentially collide with 10 large whales during training exercises and 1 large whale during testing activities over the five year period of the proposed MMPA rule.

6.3.1.1 ***Methodology for Estimation of Close Encounters Between Vessels and Cetaceans***
NMFS's requested an estimate of potential close encounters (<200 yds) based on the Navy's actual operations and available data from exercise reports. Based on this request, the Navy developed a quantitative approach to estimate close encounters based on the numbers of large whales sighted within 200 yds during major training and testing events from 2009-2012. The methodology and results are provided here as a comparative analysis to the estimated exposure to collisions with vessels. We assume that an animal has a greater risk of being struck if within 200 yds of a vessel that is underway.

Step 1. Determining an Initial Encounter Rate

To determine an encounter rate, the Navy used lookout sighting data from annual exercise reports submitted to NMFS as required under the Atlantic Fleet Active Sonar Training (AFAST) LOA and Final Rule. Applicable data includes whether the sighting was of a whale, how many were sighted, the range at which it/they were sighted, and the hours of effort spent looking. Whales sighted less than 200 yards from the vessel were considered a close encounter for the purposes of this exposure analysis.

By dividing the total number of close encounters observed each year by the hours of effort spent looking during that year, an annual close encounter rate can be estimated. The annual encounter rates were then averaged to get an overall initial encounter rate.

The following assumptions were made by the Navy regarding the sighting data used for this analysis:

- All whales sighted are ESA-listed large whale species (blue, fin, humpback, sei, sperm, and North Atlantic right whales)

- Probability of detection within the 200 yd range is 1, meaning that all whales that are available to be seen were sighted by lookouts

- Encounter rate does not differ based on season, time of day, specific geographic area, or species

Step 2. Correcting for g(0)

In order to correct for those individuals that are not available to be seen by a lookout (availability bias), the average encounter rate determined from Step 1 above is multiplied by the average g(0) value for all large whale species. The average g(0) was used because there are not species identifications in the available data. This then provides a final estimated encounter rate corrected for availability bias.

Step 3. Final Estimate of Annual Whale Close Encounters

To estimate total annual close encounters of large whales, the encounter rate determined from Step 2 above is multiplied by the total estimated number of training vessel steaming hours per year. The number of vessel steaming hours per year was estimated based on the number of vessels in the Fleet that are not deployed or in maintenance and the average number of days per quarter they are at sea based on fuel allocations.

6.3.1.2 ***Estimation of Vessel/Whale Encounters Rates and Potential Close Encounters***
Step 1.

Number of whales sighted in AFTT Study Area at ranges less than 200 yards by Navy surface ships during major training events (2009-2011) are provided in the table below.

Table 55. Number of Whales Sighted in the AFTT Study Area at Less than 200 yards during Major Training Events (2009-2011)

Year	AFTT Study Area			
	Total number of marine mammal sightings at all ranges	Total number of individual whales sighted < 200 yds*	Total observation effort during MTEs (hours)	Whale close encounter rate (# whales/hr)
2009	98	17	51756	0.00033
2010	87	8	33120	0.00024
2011	92	1	22147	0.00005
Total	**277**	**26**	**107023**	
Average				**0.00035**
*Totals include whale sightings where distance was not recorded				

Step 2.

To account for the animals that may have been missed due to availability bias, an average g(0) for all whale species was applied as a correction factor.

Table 56. Average Sightability [g(0)] for Whale Species

Species	Sightability [g(0)]
North Atlantic Right Whale	0.645
Blue Whale	0.95
Bryde’s Whale	0.95
Minke Whale	0.505
Fin Whale	0.63
Humpback Whale	0.2
Sei Whale	0.92
Sperm Whale	0.425
Average:	0.653

The correction factor of the average g(0) for all large whale species is applied to the average whale close encounter rate from step 1 to obtain the following:

Whale close encounter rate corrected for g(0) = 0.00035 * (1+(1-0.653) = **0.00048 (# whales/hr)**

Step 3.

The Navy estimated the following number of annual vessel steaming hours for training (MTEs, ULTs, transit, etc.) in the AFTT Study Area:

- Approximately 50 ships are available at any one time for training activities

- Each ship has approximately 21 days per quarter of at sea time available

= 100,800 vessel steaming hours per year

Therefore, using this data, the estimated number of close encounters per year would be:

100,800 hours per year x 0.00048 whale encounters/hour = 48 close encounters per year

These estimated 48 close encounters per year could be for any combination of the ESA-listed large whale species that are present within the AFTT Study Area (blue, fin, humpback, sei, sperm, and North Atlantic right whales). While the potential for 48 encounters with large whales at less than 200 yards exists, it is not likely (based on U.S. Navy reporting of strikes) that all of these "exposures" would result in strike or other potentially significant behavioral impacts. Factors that could contribut to reducing this estimated potential for strike or significant behavioral disturbance include natural avoidance behavior of species and Navy mitigation activities.

6.3.2 Exposure of Pinnipeds to Collisions with Vessels

The rarity of ship strikes involving pinnipeds combined with the Navy's established operating policies and procedure intended to reduce interactions of Navy assets and listed species, leads NMFS to assume that the exposure risk of collision of surface vessels and submarines with ringed seals is small enough to be discountable.

6.3.3 Exposure of Sea Turtles to Collisions with Vessels

Sea turtles often congregate close to shorelines during the breeding season, where boat traffic is denser (Schofield et al. 2007; Schofield et al. 2010a; Schofield et al. 2010b). Near shore environments include commercial shipping, research vessels, fishing vessels, military and US Coast Guard vessels and recreational boat traffic.

There have been few studies that focused solely on the interactions between sea turtles and marine vessels. Hazel and Gyuris (2006) studied the effect of recreational vessels on the mortality rates of sea turtles along the coast of Australia. (Hazel *et al.* 2007) concluded that vessel operators cannot rely on turtles to actively avoid being struck, for vessel speeds above 4 km/h. Thomas et al. (2008) found that 23 percent of sea turtle strandings on the Mediterranean coast of Spain were caused by interactions with humans, with 9 percent of the strandings a result of vessel strikes.

Vessel strike is an increasing concern, especially in the southeastern United States, where development along the coasts is likely to result in increased recreational boat traffic. In the United States, the percentage of strandings that were attributed to vessel strikes increased from approximately 10 percent in the 1980s to a record high of 20.5 percent in 2004 (NMFS and USFWS 2007f). Many vessel strikes have been documented in southeast Florida with as many as 60 percent of stranded loggerheads displaying signs of propeller-related injuries (NMFS and USFWS 2007f). Furthermore, 23 percent of sea turtle fatalities in the U.S. state of Georgia between 2004 and 2008 were attributed to impacts of ships and boats and their propulsion systems. (Hazel *et al.* 2007)

The National Marine Fisheries Service has recognized that "sea turtles are highly susceptible to vessel collisions because they regularly surface to breathe and often rest at or near the surface." seaturtles.org. Stranding networks that keep track of sea turtles that wash up dead or injured have consistently recorded vessel propeller strikes as a cause or possible cause of death. While research is limited on the relationship between sea turtles, ship collisions and ship speeds, it is clear that it is an area that needs attention and action.

Over two years, 130 sea turtles were killed by collisions with vessels along the coast of Queensland. An Australian study (Hazel et al 2007) demonstrated that slowing ship speeds is beneficial to preventing vessel collisions with sea turtles.

More large cruise and cargo ships into coastal waters and nearshore habitat globally could result in increased sea turtle mortality due to collisions, habitat destruction, and pollution from the dumping of sewage, graywater, and garbage. Ship speed reductions and environmental protections would help prevent potential harm to sea turtle populations from shipping.

We conclude that the risk of collision between Navy surface vessels and submarines, similar to recreational and commercial vessels, with green turtles, hawksbill turtles, loggerhead turtles, Kemp's ridley turtles, and leatherback turtles is small during a given exercise or training event, but possible over a five year period. While the potential for strike exists, we cannot easily quantify how many turtles or what species composition would be potentially struck.

6.3.4 **Exposure of Fish to Collisions with Vessels**

Vessels and in-water devices do not normally collide with adult fish, most of which can detect and avoid them. One study on fish behavioral responses to vessels showed that most adults exhibit avoidance responses to engine noise, sonar, depth finders, and fish finders (Jørgensen et al. 2004), reducing the potential for vessel strikes. Misund (1997) found that fish ahead of a ship that showed avoidance reactions did so at ranges of 160–490 ft. (50–350 m). When the vessel passed over them, some fish responded with sudden escape responses that included lateral avoidance or downward compression of the school. Conversely, Rostad (2006) observed that some fish are attracted to different types of vessels (e.g., research vessels, commercial vessels) of varying sizes, noise levels, and habitat locations. Fish behavior in the vicinity of a vessel is therefore quite variable, depending on the type of fish, its life history stage, behavior, time of day, and the sound propagation characteristics of the water (Schwartz 1985). Early life stages of most fish could be displaced by vessels and not struck in the same manner as adults of larger species. However, a vessel's propeller movement or propeller wash could entrain early life stages. The low-frequency sounds of large vessels or accelerating small vessels caused avoidance responses among herring (Chapman and Hawkins 1973), but avoidance ended within 10 seconds after the vessel departed. Because a towed in-water device is continuously moving, most fish are expected to move away from it or to follow behind it, in a manner similar to their responses to a vessel. When the device is removed, most fish would simply move to another area. There are a few notable exceptions to this assessment of potential vessel strike impacts on marine fish groups including sturgeon.

Vessel operations have the potential to impact smalltooth sawfish and Atlantic and Gulf sturgeon by striking animals and behaviorally harassing individuals during close encounters with vessels. Smaller military vessels operate at speeds between 25 and 39 knots (29 - 45 miles per hour) during training operations. Atlantic sturgeon are not likely to congregate in any of the training or testing areas, but may be randomly distributed throughout the areas. While smalltooth sawfish encounters are expected to be very rare (unlikely), sturgeon are expected to be distributed throughout the action area in relatively low densities.

Although the likelihood of vessel strike is small due to low densities and the ability of sturgeon to avoid vessels where there is sufficient depth in channels, the frequency of large vessel traffic in near shore environments and in and around some ports such as Norfolk presents some risk of Atlantic sturgeon being struck over time. Strike of sturgeon by recreational watercraft is well documented in many river systems. While some Navy vessels are similar to recreational watercraft in size and speed and some activities occur in riverine environments, it is not likely that small Navy vessels would strike an Atlantic sturgeon in a given year or over a five year period. This is primarily due to the fact that Atlantic sturgeon

The Atlantic Sturgeon Status Review Team, 2007, (ASSRT 2007) stated that rivers with narrow channels and large-vessel traffic have high incidences of vessel strikes on adult Atlantic sturgeon. (Brown and Murphy 2010) described the number of mortalities and the potential impact of vessel interactions on the Atlantic sturgeon population in the Delaware River. (Balazik et al. 2012). During the period of 2007 to 2010, researchers documented 31 carcasses of adult Atlantic sturgeon in the tidal freshwater portion of the James River, Virginia. Twenty-six of the carcasses had gashes from vessel propellers, and the remaining five carcasses were too decomposed to allow determination of the cause of death. While these mortalities could not be fully attributed to specific types of vessels, it is likely that they resulted from larger vessels in narrow shipping lanes. Balazik (Balazik et al. 2012) estimated that current monitoring in the James River documents less than one-third of vessel strike mortalities.

The navigation channels with a narrow widths and channel depths, form an area of increased injury and mortality risk from larger ships in comparison with downstream areas,which contain deepwater refuges for adultAtlantic sturgeon.

It is very difficult to quantify the number of Atlantic or Gulf sturgeon that would be exposed to vessels over a given year and would have some risk of being disturbed or struck by those vessels. Therefore, we cannot quantify potential take incidental to training exercises or testing activities.

6.3.5 Response of Species to Collisions with Vessels

Worldwide, many cetacean species have been documented to have been hit by transiting surface vessels (Jensen and Silber 2004a; Laist et al. 2001; Van Waerebeek et al. 2007) (Carrillo and Ritter 2010; Cole et al. 2006; David et al. 2011; Douglas et al. 2008b; Felix 2009; Felix and Waerebeek 2005; Glass et al. 2009; Lammers et al. 2003; Pace 2011; Richardson 1995a; Ritter 2009), and vessel strikes are known to affect large whales within the AFTT Study Area (Berman-Kowalewski et al. 2010; Lammers et al. 2003) (Abramson et al. 2009, Laggner 2009). The ability of a ship to detect a marine mammal and avoid a collision depends on a variety of factors, including environmental conditions, ship design, size, speed, and manning, as well as the behavior of the animal. Records of collisions date back to the early 17th century, and the worldwide number of collisions appears to have increased steadily during recent decades (Laist et al. 2001; Ritter 2012) (IWC, 2008).

NMFS Northeast Fisheries Science Center (NEFSC) developed and applied criteria to evaluate reports of human-caused injury and mortality to large whales including ship strikes. They evaluated determinations made for reports received from 2004 - 2008 involving North Atlantic right, humpback, fin, sei, blue, minke, and Bryde's whales observed along the eastern seaboard of the United States and adjacent Canadian Maritimes (Glass et al. 2010). A total of 539 unique large whale events were verified, including carcasses (both beached and at-sea) and live whales. They confirmed 57 (53%) ship strikes, and 330 mortality events. Thirty of the ship strikes were fatal. Serious injury was sustained in 2 (4%) of the confirmed ship strikes. Six (11%) of the ship strike events did not have adequate documentation to determine if serious injury occurred. Fifteen (26%) of the ship strike events were determined to have not caused serious injury or death. Of the 330 confirmed mortalities, 256 (78 percent) lacked sufficient evidence to determine cause of death. Minke whales had the greatest number of entanglement mortalities (n=11); humpback whales had the highest number of serious injury events resulting from entanglements (n=11); fin whales had the greatest number of ship strike mortalities (n=10); and right whales had the only serious injuries (n=2) from ship strikes.

In the event of a ship strike with a whale, researchers have found that the lethality of the collision increases with ship speed (Silber et al. 2010; Vanderlaan and Taggart 2007; Wiley et al. 2011)). Vanderlaan and Taggart (Vanderlaan and Taggart 2007) found the probability of a lethal strike increased from 20 percent to 100 percent at speeds between 9 and 20 knots, and that lethality from ship strike increased most rapidly between 10 and 14 knots. Similar results were reported by Pace and Silber (2005) and Wiley et al. (2011). In addition, Silber et al. (Silber et al. 2010) found that increased vessel speed increased the hydrodynamic draw of vessels that could result in right whales (and likely other species) being pulled towards vessels making them more vulnerable to collisions and increasing the magnitude of impact. Therefore, slowing ship speeds in whale dense areas is a practical mitigation measure to reduce the severity to whales of collisions with ships (Laist et al. 2001; Silber et al. 2010; Vanderlaan and Taggart 2007) (Wiley et al. 2011)(73 FR 198).

6.3.5.1 ***Responses of Cetaceans to Collisions with Vessels***

Although, the Navy's operational orders for ships that are underway are designed to prevent collisions between surface vessels participating in naval exercises and any endangered whales that might occur in the action area. These measures, which include marine observers on the bridge of ships, requirements for course and speed adjustments to maintain safe distances from whales, and having any ship that observes whales to alert other ships in the area, have historically been effective measures for avoiding collisions between surface vessels and whales in most areas. However, in the AFTT Study Area, analysis suggests that slightly over one animal per year has been struck on average. In the absence of speed restrictions that would reduce the likelihood and severity of injury from ship strikes, we assume that Navy vessels could operate over the full range of ship speeds. The disparity in size between a large whale weighing over 150 tons and an amphibious assault ship weighing 50,370 tons or a destroyer, the most prevalent type of ship in the U.S. Atlantic Fleet surface force, weighing 10,635 tons leads us to conclude that most ship strikes would result in the death of the struck animal. Based on this, we expect that if an endangered blue, fin, North Atlantic right, humpback, sei or sperm whale is struck by a Navy vessel that it would die immediately or later due to injuries sustained as a result of the collision.

As discussed above, the U.S. Navy predicted that it could encounter approximately 48 whales (excluding North Atlantic right whales) per year within a range of 0-200 yards. Of those animals encountered at this close range, the Navy estimates based on historic strike data that vessels would potentially strike up to three (3) animals per year not exceeding 10 whales in a 5-year period during training exercises and one (1) animal in a given year not exceeding 1 whale in a 5-year period during testing activities. Therefore, we would anticipate that up to four (4) whales in any given year not exceeding 11 whales in a 5-year period could be struck and likely result in mortality.

6.3.5.2 ***Responses of Sea Turtles to Collisions with Vessels***

We also conclude that encounters with vessels that result in injury or mortality are possible as with recreational boating and other vessels of similar class. Collisions with vessels would likely result in blunt trauma, lacerations, or mortality.While the probability may be low in a given year, there is potential over time for a low number of strikes by vessels and/or their propellers.

6.3.5.3 ***Responses of Fish to Collisions with Vessels***

Sturgeon occur near the surface in open-ocean, coastal and riverine areas, and are susceptible to collisions with multiple classes of vessels, but especially fast-moving boats or larger vessels in areas with minimal clearance between the propeller and bottom (e.g., coastal areas). Collisions with vessels would likely result in blunt trauma, lacerations, fin damage, or mortality. Speed et al. (2008) evaluated this specifically for whale sharks, but Gulf and Atlantic sturgeon are also likely to be susceptible because of their similar behavior and location in the water column.

As with sea turtles, the scientific information available makes it difficult to estimate the probability of the Gulf or Atlantic sturgeon being exposed to vessel traffic. Without sufficient data on densities of sturgeon in the action area, it is difficult to quantify take from collisions or entrainment.

However, we conclude that encounters with vessels that result in injury or mortality are possible as with recreational boating and other vessels of similar class. While the probability may be very low in a given year, there is potential over the five-year period assessed in this opinion or in the reasonably reasonably foreseeable future for a very low number of strikes by vessels and/or their propellers.

6.4 Risk of Ingestion of or Entanglement with Expended Materials and In-Water Devices

Expended materials pose risks for entanglement, ingestion, and release of chemicals, metals or other synthetics materials. Military expended materials include: (1) all sizes of non-explosive practice munitions, (2) fragments from high explosive munitions, and (3) expended materials other than ordnance, such as sonobuoys, ship hulks, expendable targets and unrecovered aircraft stores (fuel tanks, carriages, dispensers, racks, or similar types of support systems on aircraft).

Marine mammals, fish and sea turtles can be entangled by discarded materials including parachutes associated with flares and sonobuoys, as well as sonobuoys themselves, fiber optic cables, and guidance wires. Entanglements can result in death or injury of marine mammals and sea turtles (Hanni and Pyle 2000; Moore et al. 2009; Van Der Hoop et al. 2012).

Many of the activities the U.S. Navy plans to conduct in the AFTT Study Area firing of a variety of weapons; the use of explosive and non-explosive practice munitions such as (but not limited to) bombs, small arms ammunition, medium caliber cannons, and missiles; and the use of other military expended materials including targets, marine markers, flares, and chaff may present ingestion risks to ESA-listed species.

Table 57. Location and Number of High-Explosives that May Result in Fragments

Activity Areas	Training Exercises	Testing Activities
Torpedoes		
Other AFTT Areas (SINKEX Box)	1	0
AFTT Study Area	0	8
Total	1	8
Sonobuoys		
Northeast	170	514
VACAPES	443	950
Cherry Point	183	204
JAX	1,113	244
Key West	0	1512
GOMEX	0	204
Gulf of Mexico	0	0
Other AFTT Areas	0	368
Total	1908	3996
Neutralizers		
VACAPES (W-50)	0	0
VACAPES (W-50, W-72)	0	0
VACAPES (Little Creek)	12	0
VACAPES	60	145
JAX	0	32
NSWC PCD	0	171
GOMEX	20	0
Gulf of Mexico	0	14
Total	92	362
Anti-Swimmer Grenades		
Northeast	52	0
VACAPES	74	0
Cherry Point	28	0
JAX (Charleston OPAREA UNDET Boxes North and South)	0	0
JAX	24	0

GOMEX (CC UNDET Box E3)	0	0
GOMEX	28	0
Total	206	0
Bombs		
VACAPES (Air-K)	0	0
VACAPES	64	0
Cherry Point	32	0
JAX	32	0
GOMEX (W-155 Hotbox)	0	0
GOMEX	4	0
Other AFTT Areas (SINKEX Box)	1	0
Total	133	0
Rockets		
Northeast	0	0
VACAPES	3,800	202
Cherry Point	0	0
JAX	3,800	202
Key West	0	0
GOMEX	380	0
Total	7,980	404
Missiles		
Northeast	4	8
VACAPES (W-386, W-72, R-6604)	0	0
VACAPES [W-386 (Air E, F, I, J, K), W-72A]	0	0
VACAPES	190	42
Cherry Point [W-122 (16/17, 18/19/20/21)]	0	0
Cherry Point	91	0
JAX (MLTR)	0	0
JAX	178	13
Key West	8	0
GOMEX	8	0
Gulf of Mexico	0	4
Other AFTT Areas (SINKEX Box)	11	0
Total	490	67
Large Caliber Projectiles		
VACAPES (5C/D, 7C/D, 8C/D, 1C1/2)	0	0
VACAPES	6,644	1,797
Cherry Point [W-122 (4/5, 13/14)]	0	0

Cherry Point	866	0
JAX (BB,CC)	0	0
JAX	4,448	339
Key West	0	339
NSWC PCD	0	50
GOMEX	284	0
Other AFTT Areas (SINKEX Box)	700	0
Other AFTT Areas	96	0
AFTT Study Area	0	4,900
Total	13,038	7,425
Medium Caliber Projectiles		
VACAPES	49,936	11,200
Cherry Point	21,226	200
JAX	46,120	11,200
GOMEX	6,352	0
Other AFTT Areas	320	0
AFTT Study Area	0	3,500
Total	123,954	26,100

The Navy would expend the following types of materials that could become ingestion stressors during training and testing in the Study Area: non-explosive practice munitions (small- and medium-caliber), fragments from high-explosives, fragments from targets, chaff, flare casings (including plastic end caps and pistons), and parachutes. Other military expended materials such as targets, large-caliber projectiles, intact training and testing bombs, guidance wires, 55-gallon drums, sonobuoy tubes, and marine markers are too large for marine organisms to consume and are not discussed further in this Opinion in the context of an ingestion stressor.

Table 58. Location and Number of Expended Parachutes

Activity Area	Training Exercises	Testing Activities
Northeast	2,426	2,097
VACAPES	5,666	6,756
Cherry Point	1,897	369
JAX	23,898	2,883
Key West	12	3,120
NSWC PCD	0	0
GOMEX	12	707
Gulf of Mexico	154	38
Other AFTT Areas	584	656
AFTT Study Area	0	432
Total	**34,650**	**17,058**

Expended materials include fiber optic cables, guidance wires, parachutes, and potentially ingestible materials such as munitions, targets (Table 59), chaff, flares, and parachutes (Table 58).

Table 59.Number and Location of Targets Expended During Training and Testing

Activity Area	Training Exercises	Testing Activities
Sub-Surface Targets		
Northeast	116	128
VACAPES	447	471
Cherry Point	125	9
JAX	1,492	199
GOMEX	0	35
Gulf of Mexico	5	4
Other AFTT Areas	122	16
Total	**2,306**	**862**
Surface Targets		
Northeast	11	4
VACAPES	1,538	936
Cherry Point	364	0
JAX	1,067	287
GOMEX	92	10
Gulf of Mexico	0	2
Other AFTT Areas	44	0
AFTT Study Area	0	3
Total	**3,116**	**1,242**
Air Targets		
VACAPES	0	121
Total	**0**	**121**
Mine Shapes		
VACAPES	48	114
Cherry Point	24	0
JAX	12	60
NSWC PCD	0	435
Gulf of Mexico	0	7
Total	**84**	**616**
Ship Hulk		
Other AFTT Areas (SINKEX Box)	1	0
Total	**5,507**	**2,841**

Debris ingestion and entanglement is an ongoing threat to sea turtles. Debris from U.S. Navy training activities includes parachutes from flares, chaff (Figure 29), and wires from missiles. None of the above item types have been documented to be ingested by sea turtles or Gulf or Atlantic sturgeon. The flare parachutes are made for one-time use, and according to Navy observations do not persist long in the environment.

Sperm whales are recorded as having ingested fishing net scraps, rope, wood, and plastic debris such as plastic bags and items from the seafloor (Walker and Coe 1990; Whitehead 2003b). Recently weaned juveniles, who are investigating multiple types of prey items, may be particularly vulnerable to ingesting non-food items as found in a study of juvenile harbor porpoise (Baird and Hooker 2000). A male pygmy sperm whale reportedly died from blockage of two stomach compartments by hard plastic, and a Blainville's beaked whale (*Mesoplodon densirostris*) washed ashore in Brazil with a ball of plastic thread in its stomach (Derraik 2002b). In a comprehensive review of documented ingestion of debris by marine mammals, odontocetes had the most ingestion records with 21 species represented (Laist 1997). Of these odontocete species, only sperm whale, Blainville's beaked whale, Cuvier's beaked whale had ingested non-floating items (i.e., stones, concrete, metal, glass) presumably while foraging from the seafloor.

Table 60. Number and Location of Non-explosive Practice Munitions Expended

Activity Area	Training Exercises	Testing Activities
AMNS Neutralizers		
VACAPES	570	77
Cherry Point	71	0
JAX	71	32
NSWC PCD	0	140
GOMEX	112	0
Total	**824**	**249**
Torpedoes		
VACAPES	0	30
JAX	0	7
Total	**0**	**37**
Bombs		
VACAPES	610	905
Cherry Point	1,163	0
JAX	1,261	240
GOMEX	335	0
Total	**3,369**	**1,145**
Rockets		
VACAPES	0	2,102
JAX	0	561
Total	**0**	**2,633**
Missiles		

Northeast	0	0
VACAPES	2	658
Cherry Point	0	0
JAX	2	62
Key West	0	3
GOMEX	0	10
Gulf of Mexico	0	0
AFTT Study Area	0	1
Total	**4**	**734**
Large Caliber Projectiles		
Northeast	0	296
VACAPES	1,804	4,811
Cherry Point	934	0
JAX	1,832	769
Key West	0	561
NSWC PCD	0	280
GOMEX	1,276	0
Gulf of Mexico	0	148
Other AFTT Areas	537	0
AFTT Study Area	0	7,100
Total	**6,383**	**13,965**
Medium Caliber Projectiles		
Northeast	700	1,400
VACAPES	807,810	162,590
Cherry Point	215,149	22,200
JAX	415,075	68,600
Key West	56,000	6,000
NSWC PCD	0	18,718
GOMEX	24,388	0
Gulf of Mexico	0	1,400
Other AFTT Areas	33,520	0
AFTT Study Area	0	3,500
Total	**1,552,642**	**284,408**
Small Caliber Projectiles		
Northeast	27,500	0
VACAPES	3,857,600	7,633
Cherry Point	543,740	3,333
JAX	1,534,500	3,333
NSWC PCD	0	7,000
GOMEX	73,200	0

Gulf of Mexico	0	28,000
Other AFTT Areas	227,500	0
AFTT Study Area	0	2,500
Total	**6,264,040**	**51,800**
Overall Total	**7,827,262**	**354,970**

Chaff strands are likely too fine to block the digestive tract of sea turtles, and are non-toxic in quantities that could be ingested. We evaluated the potential for harm as a result of incidental ingestion of chaff by sea turtles and concluded that there is not a significant or measurable likelihood of harm as from potential ingestion of chaff fibers which fall into the waters during training exercises, nor from other debris (flare parachutes, etc.) that are left in the water following each exercise.

Figure 29.Chaff. Courtesy of the Naval Research Laboratory, Dr. Barry J. Spargo.

North American sturgeons including Atlantic sturgeon normally ingest organic and inorganic detritus incidentally during the feeding process (Dadswell et al. 1984; Smith 1985) (Ryder 1890; Vladykov 1948; Semakula and Larkin 1968). It is possible that sturgeon could ingest expended chaff fibers during feeding.

In a 1999 report to the Undersecretary of Defense for Environmental Security titled *Environmental Effects of RF Chaff*, the Panel reported that because of its fibrous glass composition, chaff does have the potential to cause physical harm to gut mucosa if ingested. Very little research has examined this potential. The report cited one unpublished study, a report to the Director of Canadian Electronic Warfare fed aluminum coated fiberglass chaff to beef calves (approximately 180 kg live weight) at up to 7 g day. It is instructive that a preliminary investigation found that the animals rejected the chaff outright, and that the material had to be evenly scattered over the grain ration and thoroughly mixed with molasses before the calves would eat it. The feeding treatments were applied for up to 39 consecutive days, during which time no differences were shown between chaff-fed and control animals in terms of weight gain or blood chemistry. Post-mortem examination, including a detailed histological examination of sections of the entire gut showed no lesions. Small chaff fragments found trapped in between the villi of the reticulum did not appear to have provoked any cellular reaction. Based on these results, MacKay concluded that long-term tests for chronic toxicity were unwarranted.

In a report prepared by Systems Consultants, Inc. {, 1977 #155868} it was reported that direct exposure of six marine organisms from Chesapeake Bay to chaff fibers had no significant impact on the mortality of any of the species. Blue crab (*Callinectes sapidus*), menhaden (*Brevoortia tyrannus*), and killifish (*Fundulus heteroclitus*) were force fed whole and broken fibers for several weeks at concentrations up to 1000-times greater than those in the Bay itself, with no effect. Oyster larvae (*Crassostrea virginica*) exposed at 10- and 100-times the environmental exposure showed no effect, though there was a small decrease in the size of 10-day-old larvae at 1000-times the environmental exposure. The polychaete worm (*Nereis succine*) was exposed to chaff at 10-times the environmental exposure with no effect.

Wilson (2002) analyzed effects of chaff release on aluminum levels in the Chesapeake Bay and found a less than two-fold increase in the content of organic monomeric aluminum in samples taken from the affected area versus background samples, whereas inorganic monomeric aluminum concentrations within the affected area were significantly lower than background. These results suggest that chaff releases have not resulted in a significant accumulation of aluminum in that training area. We expect similar findings in AFTT Study Area and nearshore range complexes and do not expect ingestion of chaff strands or other expended materials to be likely. Therefore, ingestion of expended materials is not considered further in this Opinion.

At-sea targets are usually remotely-operated airborne, surface, or subsurface traveling units, most of which are designed to be recovered for reuse. However, if they are used during activities that utilize high-explosives then they may result in fragments. Expendable targets that may result in fragments would include air-launched decoys, surface targets (such as marine markers, paraflares, cardboard boxes, and 10 ft. diameter red balloons), and mine shapes. Most target fragments would sink quickly to the seafloor. Floating material, such as Styrofoam, may be lost from target boats and remain at the surface for some time.

6.4.1 Exposure of Marine Mammals to Ingestion of or Entanglement with Expended Materials and In-water Devices

Species that feed at the surface or in the water column include blue, fin, and sei whales. While humpback whales feed predominantly by lunging through the water after krill and fish, there are instances of humpback whales disturbing the bottom in an attempt to flush prey, the northern sand lance (*Ammodytes dubius*) (Hain et al. 1995). Humpback whales feed while in northeastern waterts. Humpback whales may forage while present in the southern portion of the Study Area although are not likely to forage at the seafloor in this area. Based on the available evidence, since humpback whales are known to forage at the seafloor, it is possible but unlikely they may ingest items found on the seafloor.

Sperm whales are known to incidentally ingest foreign objects while foraging; however, this does not always result in negative consequences to health or vitality (Laist 1997; Walker and Coe 1990). While this incidental ingestion has led to sperm whale mortality in some cases, Whitehead (2003b) suggested the scale to which this affects sperm whale populations was not substantial. Sperm whales are recorded as having ingested fishing net scraps, rope, wood, and plastic debris such as plastic bags and items from the seafloor (Walker and Coe 1990; Whitehead 2003b).

Training exercises and testing activities involving small- and medium-caliber non-explosive practice munitions would involve the use of small and medium-caliber projectiles that could be encountered by marine mammals or sea turtles. (See Table 57 and Table 60) The potential for such an encounter is low based on the patchy distribution of both the projectiles and an animal's feeding habitat. An animal would not likely ingest every projectile it encountered. Furthermore, an animal may attempt to ingest a projectile and then reject it when it realizes it is not a food item. Even ingestion of certain items (hooks), if they do not become embedded in tissue, do not end up resulting in injury or mortality to the individual (Wells et al. 2008). Therefore potential impacts of non-explosive practice munitions ingestion would be limited to the unlikely event where a marine mammal or sea turtle might suffer a negative response from ingesting an item that becomes embedded in tissue or is too large to be passed through the digestive system.

Expended materials have the potential to entangle and could be encountered by marine mammals in the AFTT Study Area at the surface, in the water column, or along the seafloor. There has never been a reported or recorded instance of a marine mammal entangled in military expended materials; however, the possibility still exists. Since potential impacts depend on how a marine mammal encounters and reacts to items that pose an entanglement risk, the following subsections discuss research relevant to specific groups or species. Most documented entanglements are marine mammal encounters with fishing gear or other non-military materials that float or are suspended at the surface.

Fiber optic cables and guidance wires would be in the water column during the training or testing activity and while they sink. Bottom feeding animals have an increased likelihood of encounter because they may find the item and become entangled during feeding long after the training or testing event has occurred. Fiber optic cable is brittle and would be expected to break if kinked, twisted or sharply bent. Thus, the physical properties of the fiber optic cable would not allow the cable to loop, greatly reducing the potential of entanglement of ESA-listed species.

Similar to fiber optic cables, guidance wires may pose an entanglement threat to ESA-listed species either in the water column or after the wire has settled to the sea floor. The likelihood of a marine mammal encountering and becoming entangled in a guidance wire depends on several factors. Since the guidance wire will only be within the water column during the activity and while it sinks (at an estimated rate of 0.7 ft. [0.2 m] per second), the likelihood of a marine mammal encountering and becoming entangled within the water column is very low. It is more likely that a marine mammal would encounter a guidance wire once it had settled on the sea floor. In addition, based on degradation times the guide wires would break down within one to two years and therefore no longer pose an entanglement risk. The length of the guidance wires vary, but greater lengths increase the likelihood that a marine mammal or sea turtle could become entangled. The behavior and feeding strategy of a species can determine whether they may encounter items on the seafloor, where guidance wires will most likely be available.

The chance that an individual animal would encounter expended parachutes is low based on the distribution of the parachutes expended, the fact that parachute assemblies are designed to sink upon release, and the relatively few animals that feed on the bottom. If a marine mammal did become entangled in a parachute, it could easily become free of the parachute because the parachutes are made of very light-weight fabric.

The possibility of a sperm whale becoming entangled exists when they are feeding on the bottom in areas where parachutes have been expended. This is unlikely as parachutes are used in events that generally occur in deeper waters where these species are not likely to be feeding on the bottom, though even if momentarily entangled, a marine mammal would likely be able to free themselves of the light weight fabric of a parachute. There has never been any recorded or reported instance of a marine mammal becoming entangled in a parachute.

Heezen (1957) reported two confirmed instances of sperm whales entangled in the slack lengths of telegraph cable near cable repair sites along the seafloor. These whales likely became entangled while feeding along the bottom, as the cables were most often found wrapped around the jaw. Juvenile harbor porpoise exposed to 0.5 in. diameter (13 millimeters [mm] diameter) white nylon ropes in both vertical and horizontal planes treated the ropes as barriers, more frequently swimming under than over them. However, harbor porpoise feeding on fish in the area crossed the ropes more frequently and became less cautious, suggesting that rope poses a greater risk in a feeding area than in a transit area. For harbor porpoise feeding on the bottom, rope suspended near the seafloor is more likely to entangle than rope higher in the water column because the animals' natural tendency is to swim beneath barriers (Kastelein et al. 2005b).

Military expended materials are generally expected to sink to the ocean floor and therefore pose a risk to individual animals for a relatively short period of time. Although there is a potential for ESA-listed species to encounter military expended material, we cannot determine whether such interactions are probable, given the relatively small number of materials that would be expended during any given exercise or training event, the large geographic area involved, and the relatively low densities of threatened or endangered marine mammals and sea turtles in the AFTT Study Area.

The chance that an individual animal would encounter expended cables or wires is low based on the distribution of both the cables and wires expended the fact that the wires and cables will sink upon release and the relatively few cetaceans and pinnipeds that are likely to feed on the bottom in the deeper waters where these would be expended. It is also unlikely that an animal would get entangled even if it encountered a cable or wire while it was sinking or upon settling to the seafloor. An animal would have to swim through loops or become twisted within the cable or wire to become entangled, and given the properties of the expended cables and wires (low breaking strength and sinking rates).

Entanglement of a marine mammal in a parachute assembly at the surface or within the water column would be unlikely, since the parachute would have to land directly on an animal, or an animal would have to swim into it before it sinks. The table below indicates the number of parachutes anticipated to be expended during training exercises and testing activities in the AFTT Study Area. Once on the seafloor, if bottom currents are present, the canopy may temporarily billow 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 seafloor and accidental entanglement in the canopy or suspension lines is unlikely.

The chance that an individual animal would encounter expended parachutes is low based on the distribution of the parachutes expended, the fact that parachute assemblies are designed to sink upon release, and the relatively few animals that feed on the bottom. If a marine mammal did become entangled in a parachute, it could easily become free of the parachute because the parachutes are made of very light-weight fabric.

Parachutes are used in events that generally occur in deeper waters where large whale species are not likely to be feeding on the bottom, though even if momentarily entangled, a marine mammal would likely be able to free themselves of the light weight fabric of a parachute. There has never been any recorded or reported instance of a marine mammal becoming entangled in a parachute.

Therefore, potential exposure to in-water devices and expended material that may result in changes to an individual's behavior, growth, survival, annual reproductive success, lifetime reproductive success (fitness), or species recruitment are very low. As such potential risk to ceataceans and pinnipeds from expended materials and in-water devices is not discussed further in this Opinion.

6.4.2 Exposure of Sea Turtles to Ingestion of or Entanglement with Expended Materials and In-water Devices

In-water devices are generally smaller (several inches to 111 ft. [34 m]) than most Navy vessels. Devices that pose the greatest collision risk to sea turtles are those that are towed or operated at high speeds, including remotely operated high-speed targets and mine warfare systems. Devices that move slowly through the water column have a very limited potential to strike a sea turtle because sea turtles in the water could avoid a slow-moving object.

Any species of sea turtle that occurs in the Study Area could at some time encounter expended cables or wires. The sink rates of cables and wires would rule out the possibility of these drifting great distances into nearshore and coastal areas where green, hawksbill, Kemp's ridley, and loggerhead turtles are more likely to occur and feed on the bottom. The leatherback is more likely to co-occur with these activities, given its preference for open-ocean habitats, but this species is known to forage on jellyfish at or near the surface.

The likelihood of a sea turtle encountering and becoming entangled in a fiber optic cable or guidance wire depends on several factors. The amount of time that the fiber optic cable or guidance wire is in the same vicinity as a sea turtle can increase the likelihood of it posing an entanglement risk. Since these items will only be within the water column during the activity and while it sinks, the likelihood of a sea turtle encountering and becoming entangled within the water column is extremely low.

Because of the physical characteristics of parachutes, they pose a potential, though unlikely, entanglement risk to sea turtles. The parachute and housing are designed to sink to the seafloor and become flattened after being on the surface for a very short time. Parachutes or lines associated with the parachute may present a potential risk for sea turtles to become entangled, particularly while at the surface. To become entangled, a sea turtle would have to surface to breathe or grab prey from under the parachute, and swim into the parachute or the associated lines, during the brief time before the parachute sinks to the bottom.

While in the water column, a sea turtle is not likely to become entangled because the parachute would have to land directly on the turtle, or the turtle would have to swim into the parachute before it sank. If the parachute and associated lines sink to the seafloor in an area where the bottom is calm, it would remain there undisturbed. In an area with bottom currents or active tidal influence, the parachute may move along the seafloor, away from the location in which it was expended. Over time, it may become covered by sediment in most areas or colonized by attaching and encrusting organisms, which would further stabilize the material and reduce the potential for reintroduction as an entanglement risk. Bottom-feeding sea turtles tend to forage in nearshore areas rather than offshore, where these parachutes are used; therefore, green, hawksbill, Kemp’s ridley, and loggerhead sea turtles are not likely to encounter parachutes once they reach the seafloor. The potential for a leatherback sea turtle to encounter an expended parachute while feeding at the surface or in the water column is still extremely low, given the sink rate of the parachute, and is even less probable at the seafloor, given the general behavior of the species to feed near the surface.

Sublethal impacts due to ingestion of munitions used in training and testing activities may cause short-term or long-term disturbance to an individual turtle because (1) if a sea turtle were to incidentally ingest and swallow a projectile or solid metal high-explosive fragment, it could potentially disrupt its feeding behavior or digestive processes and (2) if the item is particularly large in proportion to the turtle ingesting it, the item could become permanently encapsulated by the stomach lining, with a rare chance that this could impede the turtle’s ability to feed or take in nutrients. Potential impacts of exposure to munitions may result in changes to an individual’s behavior, growth, survival, annual reproductive success, lifetime reproductive success (fitness), or species recruitment. However, munitions used in training and testing activities are generally not expected to cause disturbance to sea turtles because (1) sea turtles are not expected to encounter most small- and medium-caliber projectiles or high-explosive fragments on the seafloor because of the depth at which these would be expended; and (2) in some cases, a turtle would likely pass the projectile through its digestive tract and expel the item without impacting the individual.

Several different types of materials other than munitions are expended at sea during training and testing activities. The following military expended materials other than munitions have the potential to be ingested by sea turtles:

- Target-related materials
- Chaff (including fibers, end caps, and pistons)
- Flares (including end caps and pistons)
- Parachutes (cloth, nylon, and metal weights)

Sublethal impacts due to ingestion of military expended materials other than munitions used in training and testing activities may cause short-term or long-term disturbance to an individual turtle because (1) if a sea turtle were to incidentally ingest and swallow a parachute, target fragment, chaff or flare component, it could potentially disrupt its feeding behavior or digestive processes and (2) if the item is particularly large in proportion to the turtle ingesting it, the item could become permanently encapsulated by the stomach lining, with a rare chance that this could impede the turtle's ability to feed or take in nutrients.

However, parachutes, target fragments, chaff, and flare components used in training and testing activities are generally not expected to cause disturbance to sea turtles because (1) leatherbacks are likely to forage further offshore than within range complexes, and other sea turtles primarily forage on the bottom in nearshore areas; (2) in some cases, a turtle would likely pass the item through its digestive tract and expel the item without impacting the individual; and (3) chaff, if ingested, would occur in very low concentration and is similar to spicules, which sea turtles ingest without harm. In addition, the impacts of ingesting these forms of expended materials on sea turtles would be minor because of the following factors:

- The limited geographic area where materials other than munitions are expended during a given event
- The limited period of time these military expended materials would remain in the water column
- The unlikely chance that a sea turtle might encounter and swallow these items on the seafloor
- The ability of sea turtles to reject and not swallow nonfood items incidentally ingested

Therefore, potential exposure to in-water devices and expended material that may result in changes to an individual's behavior, growth, survival, annual reproductive success, lifetime reproductive success (fitness), or species recruitment are very low. As such potential risk to sea turtles from expended materials and in-water devices is not discussed further in this Opinion.

6.4.3 Exposure of Fish to Ingestion of or Entanglement with Expended Materials and In-water Devices

The likelihood of fish being affected by an entanglement stressor is a function of the physical properties, location, and buoyancy of the object and the behavior of the. Two types of military expended materials were assessed by the Navy and are considered here: (1) cables and wires, and (2) parachutes.

Most entanglement observations involve abandoned or discarded nets, lines, and other materials that form loops or incorporate rings (Derraik 2002a; Keller et al. 2010; Laist 1987; Macfadyen et al. 2009). A 25-year dataset assembled by the Ocean Conservancy reported that fishing line, rope, and fishing nets accounted for 68 percent of fish entanglements, with the remainder due to encounters with various items such as bottles, cans, and plastic bags (Ocean Conservancy 2010). No occurrences involving military expended materials have been documented.

Some fish are more susceptible to entanglement in derelict fishing gear and other marine debris, compared to other fish groups. Physical features, such as rigid or protruding snouts of sawfish and sturgeon increase the risk of entanglement compared to fish with smoother, more streamlined bodies (e.g., lamprey and eels). Sawfish occur only in nearshore, and coastal waters of the Gulf of Mexico Large Marine Ecosystem and very limited portions of the Southeast U.S. Continental Shelf Large Marine Ecosystem (FR 74 (169): 45353-45359, September 2, 2009; FR 74 (144): 37671-37674, July 29, 2009), where they are concentrated in south Florida and the Florida Keys. ESA-listed sturgeon species occur in each of the large marine ecosystems that overlap Navy training and testing areas in the Study Area, within nearshore and offshore waters.

Fiber optic cables and guidance wires are used during training and testing activities. Once a guidance wire is released, it is likely to sink immediately and remain on the seafloor. In some cases, the wire may snag on a hard structure near the bottom and remain partially or completely suspended. In any situation, the most likely mechanism for entanglement would involve fish swimming through loops in the wire that tighten around it; however, loops are unlikely to form in guidance wire (Environmental Sciences Group 2005).

Because of their physical characteristics, guidance wires and fiber optic cables pose a potential, though unlikely, entanglement risk to susceptible fish. Potential entanglement scenarios are based on fish behavior in abandoned monofilament, nylon, and polypropylene lines used in commercial nets. Such derelict fishing gear is abundant in the ocean (Macfadyen et al. 2009) and pose a greater hazard to fish than the very thin wire expended by the Navy. Fishing gear materials often have breaking strengths that can be up to orders of magnitude greater than that of guidance wire and fiber optic cables (Environmental Sciences Group 2005), and are far more prone to tangling. Fiber optic cables do not easily form loops, are brittle, and break easily if bent, so they pose a negligible entanglement risk. Additionally, the encounter rate and probability of impact from guidance wires and fiber optic cables are low, as few are expended and therefore, have limited overlap with sawfish or sturgeon and are not considered further in this Opinion.

Parachutes of varying sizes are used during training and testing activities. Once a parachute has been released to the water, it poses a potential entanglement risk to fish. The Naval Ocean Systems Center identified the potential impacts of torpedo air launch accessories, including parachutes, on fish (U.S. Department of the Navy 1996). Unlike other materials in which fish become entangled (such as gill nets and nylon fishing line), the parachute is relatively large and visible, reducing the chance that visually oriented fish would accidentally become entangled in it. No cases of fish entanglement have been reported for parachutes (Ocean Conservancy 2010; U.S. Department of the Navy 2001). Entanglement in a newly expended parachute while it is in the water column is unlikely because fish generally react to sound and motion at the surface with a behavioral reaction by swimming away from the and would detect the oncoming parachute in time to avoid contact. While the parachute is sinking, fish would have ample opportunity to swim away from the large moving object. Even if the parachute landed directly on a fish, it would likely be able to swim away faster than the parachute would sink because the resistance of the water would slow the parachute's downward motion.

Once the parachute is on the bottom, however, it is feasible that a fish could become entangled in the parachute or its suspension lines while diving and feeding, especially in deeper waters where it is dark. If the parachute dropped in an area of strong bottom currents, it could billow open and pose a short-term entanglement threat to large fish feeding on the bottom. Benthic fish with elongated spines could become caught on the parachute or lines. A fish with spines or protrusions, such as sturgeon and sawfish, on its body that swam into the parachute or a loop in the lines, and then struggled, could become bound tightly enough to prevent escape. Although this scenario is possible based on the structure of the materials and the shape and behavior of fish, it is not considered a likely event and not discussed further in this Opinion.

It is reasonable to assume that any item of a size that can be swallowed by a fish could be eaten at some time; the Navy's analysis focused on ingestion of materials in two locations: (1) at the surface or water column, and (2) at the seafloor. The potential for ESA-listed fish species to encounter and ingest expended materials is evaluated with respect to their feeding group, size, and geographic range, which influence the probability that they would eat military expended materials.

The Navy expends the following types of materials during training and testing in the Study Area that could become ingestion stressors: non-explosive practice munitions (small- and medium-caliber), fragments from high-explosives, fragments from targets, chaff, flare casings (including plastic end caps and pistons), and small parachutes.

Metal items eaten by marine fish are generally small (such as fish hooks, bottle caps, and metal springs), suggesting that small- and medium-caliber projectiles, pistons, or end caps (from chaff canisters or flares) are more likely to be ingested. Both physical and toxicological impacts could occur as a result of consuming metal or plastic materials (Davison and Asch 2011); (Dantas et al. 2012; Possatto et al. 2011). Items of concern are those of ingestible size that either drift at or just below the surface (or in the water column) for a time or sink immediately to the seafloor. The likelihood that expended items would cause a potential impact on a given fish species depends on the size and feeding habits of the fish and the rate at which the fish encounters the item and the composition of the item. In the Navy's analysis and in this Opinion, only small- and medium-caliber munitions (or small fragments from larger munitions), chaff, small parachutes, and end caps and pistons from flares and chaff cartridges are considered to be of ingestible size for a fish. For many small fish species (e.g., herring, anchovy, etc.), even these items (with the exception of chaff) are too large to be ingested. Therefore, the discussion in this section focuses on those fish species large enough to potentially ingest these materials.

Bottom-dwelling fish in the nearshore coasts and estuaries may feed by seeking prey and by scavenging on dead fish and invertebrates. All sturgeon in the Study Area suction-feed along the bottom in coastal waters on small fish and invertebrate prey, which increases the likelihood of incidental ingestion of marine debris (Ross et al. 2009). The smalltooth sawfish primarily inhabits nearshore habitats in southern Florida and other gulf coast locations, such as seagrass beds and mangroves.

The Atlantic and Gulf sturgeon may occur in portions of the Study Area out to the continental shelf break where projectiles and munitions are used. The current Chesapeake Bay system population of shortnose sturgeon appears to be centered in the upper Chesapeake Bay (Welsh et al. 2002b), outside of the Study Area. Training activities expending projectiles or munitions could expose sturgeon to ingestion risk. However, if a sturgeon ingested a small-caliber projectile or fragment, no change to its growth, survival, annual reproductive success, or lifetime reproductive success would be likely to occur. Smalltooth and largetooth sawfish could encounter some ordnance-related material; although the likelihood is remote because there are no small-caliber projectiles expended in the Key West Range Complex portion of the Study Area where sawfish would most likely occur. Most ordnance used during training is expended in deep waters beyond the continental shelf break, where sawfish are not expected to occur.

The potential impacts on smalltooth sawfish are discountable because they are historically rare in the locations where munitions are expended. The likelihood of ingestion of munitions (or fragments) by early life stages of sawfish would be slightly less than that of adults because nursery habitats are found in very shallow water (less than 1 m), where no munitions would be expended. Early life stages of sturgeon are typically found in freshwater rivers and not in marine environments, so only juveniles and adults would be potentially exposed to ingestion stressors.

Therefore, potential exposure to ingestion of in-water devices and expended material that may result in changes to an individual's behavior, growth, survival, annual reproductive success, lifetime reproductive success (fitness), or species recruitment are very low. As such potential risk to Atlantic and Gulf sturgeon and smalltooth sawfish from ingestion of expended materials and in-water devices is not discussed further in this Opinion.

6.5 Risk of Disturbance and Direct Strike from Expended Materials

In this Opinion, we assessed risk and potential exposure from disturbance and strike of ESA-listed species from expended materials from the following items:

- Sonobuoys: Sonobuoys consist of parachutes and the sonobuoys themselves.
- Torpedo Launch Accessories: Torpedoes are usually recovered; however, materials such as parachutes used with air-dropped torpedoes, guidance wire used with submarine-launched torpedoes, and ballast weights are expended. Explosive filled torpedoes expend torpedo fragments.
- Projectiles and Bombs: Non-explosive projectiles, non-explosive bombs, or fragments from explosive projectiles and bombs are expended during training and testing exercises. These items are primarily constructed of lead (most small-caliber projectiles) or steel (medium- and large-caliber projectiles and all bombs).

- Missiles and Rockets: Non-explosive missiles and missile fragments from explosive missiles are expended during training and testing events. Propellant, and any explosive material involved, is consumed during firing/detonation. Some missiles include a wire, which is also expended. Rockets are similar to missiles and both non-explosive and fragments may be expended.
- Targets: Some targets are designed to be expended; other targets, such as aerial drones and remote-controlled boats, are recovered for re-use. Targets struck with ordnance will result in target fragments.

Physical disturbance and strike stressors from expended materials, and seafloor devices have the potential to affect ESA-listed marine mammals, fish and sea turtles in the AFTT Study Area.

During a sinking exercise, aircraft, ship, and submarine crews fire or drop munitions on a seaborne target, usually a clean deactivated ship, which is deliberately sunk using multiple weapon systems. Sinking exercises occur in specific open ocean areas, outside of the coastal range complexes, in waters exceeding 3,000 m in depth. Direct ordnance strikes from the various weapons used in these exercises are a source of potential impact.

Various types of projectiles could cause a temporary (seconds), localized impact when they strike the surface of the water. Current Navy training and testing in the Study Area, such as gunnery exercises, include firing a variety of weapons and using a variety of non-explosive training and testing rounds, including 5-in. naval gun shells, and small-, medium-, and large-caliber projectiles. See Table 60 for information regarding the number and location of activities involving non-explosive practice munitions. The larger-caliber projectiles are primarily used in the open ocean beyond 20 nm. Direct ordnance strikes from firing weapons are potential stressors to fish.

Various projectiles will fall on soft or hard bottom habitats, where they could either become buried immediately in the sediments, or sit on the bottom for an extended time period. Except for the 5-in. and the 30 mm rounds, which are fired from a helicopter, all projectiles would be aimed at surface targets. These targets will absorb most of the projectiles' energy before they strike the surface of the water and sink. This factor would limit the possibility of high-velocity impacts with fish from the rounds entering the water.

Most munitions would sink through the water column and come to rest on the seafloor, stirring up sediment and possibly inducing a startle response, displacing, or injuring animals in extremely rare cases. Particular impacts on a given species would depend on the size and speed of the munitions, the water depth, the number of rounds delivered, the frequency of training and testing, and the sensitivity of the species.

Direct munitions strikes from bombs, missiles, and rockets are potential stressors to some species. Some individuals at or near the surface may be struck directly if they are at the point of impact at the time of non-explosive practice munitions delivery. However, most missiles hit their target or are disabled before hitting the water. Thus, most of these missiles and aerial targets hit the water as fragments, which quickly dissipates their kinetic energy within a short distance of the surface.

Propelled fragments (Table 57) are produced by an exploding bomb. Close to the explosion, individuals could potentially sustain injury or death from propelled fragments (Stuhmiller et al. 1990). However, studies of underwater bomb blasts show that fragments are larger than those produced during air blasts and decelerate much more rapidly (O'Keeffe and Young 1984; Swisdak Jr. and Montaro 1992), reducing the risk to marine organisms.

6.5.1 Exposure of Cetaceans to Disturbance and Direct Strike from Expended Materials

The Navy analyzed the strike potential to cetaceans from the following categories of military expended materials (1) non-explosive practice munitions, (2) fragments from high-explosive munitions and (3) expended materials other than munitions, such as sonobuoys and expendable targets. While disturbance or strike from an item as it falls through the water column is possible, it is not very likely because the objects generally sink through the water slowly and can be avoided by most cetaceans. Therefore, the discussion of military expended materials strikes will focus on the potential of a strike at the surface of the water.

While no strike from military expended materials has ever been reported or recorded, the possibility of a strike still exists. Therefore, the potential for cetaceans to be struck by military expended materials was evaluated using statistical probability modeling to estimate the likelihood. Specific details of the modeling approach including model selection and calculation methods can be found in Appendix G, (Statistical Probability Model for Estimating Direct Strike

Table 61. Probability of a Military Expended Materials Strike for Cetaceans by Area (FEIS/OEIS)

Northeast United States Continental Shelf Large Marine Ecosystem and Gulf Stream Open Ocean Area		
Virginia Capes (VACAPES) Range Complex		
Species	**Training Exercises**	**Testing Activities**
North Atlantic Right Whale	0.00%	0.00%
Humpback Whale	0.01%	0.01%
Sei Whale	0.05%	0.06%
Fin Whale	0.03%	0.04%
Blue Whale	0.00%	0.00%
Sperm Whale	0.16%	0.25%
Southeast United States Continental Shelf Large Marine Ecosystem and Gulf Stream Open Ocean Area		
Jacksonville (JAX) Range Complex		
North Atlantic Right Whale	0.00%	0.00%
Humpback Whale	0.00%	0.00%
Sei Whale	0.02%	0.00%
Fin Whale	0.01%	0.00%
Blue Whale	0.00%	0.01%
Sperm Whale	0.02%	0.24%

Impact and Number of Potential Exposures of the FEIS/OEIS which estimates the highest probability of striking a whale. Input values include munitions data (frequency, footprint, and type), size of the training and testing area, marine mammal density data, and size of the animal (area of potential impact). To estimate the potential to strike a whale, the highest probability of a strike was calculated by totaling the impact area of all bombs and projectiles over one year in the training or testing area for each alternative with the highest projected use (concentration of military expended materials), and using the whale densities within the activity at each location. Table 61 provides the results for VACAPES and Jacksonville Range Complexes.

Based on these results we conclude that disturbance or direct strike of cetaceans by expended materials is not likely to result from training and testing activities during a given year or during the five year period. As such, we did not assess potential responses and exposure would be unlikely.

6.5.2 **Exposure of Pinnipeds to Disturbance and Direct Strike from Expended Materials**

The Navy determined that proposed training and testing activities that involve the use of military expended materials do not overlap with ringed seal habitat.

Therefore, we conclude that disturbance or direct strike of ringed seals by expended materials is not likely to result from training and testing activities during a given year or during the five year period. As such, we did not assess potential responses as exposure would be unlikely.

6.5.3 **Exposure of Sea Turtles to Direct Strike from Expended Materials**

The Navy analyzed the strike potential to sea turtles from the following categories of military expended materials (1) non-explosive practice munitions (Table 60), (2) fragments from high-explosive munitions (Table 57) and (3) expended materials other than munitions, such as sonobuoys and expendable targets. While disturbance or strike from an item as it falls through the water column is possible, it is not very likely because the objects generally sink through the water slowly and can be avoided by most sea turtles. Therefore, the discussion of military expended materials strikes will focus on the potential of a strike at the surface of the water.

While no strike from military expended materials has ever been reported or recorded, the possibility of a strike still exists. Therefore, the potential for sea turtles to be struck by military expended materials was evaluated using statistical probability modeling to estimate the likelihood. Specific details of the modeling approach including model selection and calculation methods can be found in Appendix G, (Statistical Probability Model for Estimating Direct Strike Impact and Number of Potential Exposures) of the FEIS/OEIS which estimates the highest probability of striking a sea turtle. Input values include munitions data (frequency, footprint, and type), size of the training and testing area, sea turtle density data, and size of the animal (area of potential impact). To estimate the potential to strike a sea turtle, the highest probability of a strike was calculated by totaling the impact area of all bombs and projectiles over one year in the training or testing area for each alternative with the highest projected use (concentration of military expended materials), and using the sea turtle species with the highest average seasonal density within the activity at each location. These highest estimates would then provide a point of comparison for all other areas and species. The areas with the greatest concentration of expended materials are expected to be the Northeast U.S. Continental Shelf Large Marine Ecosystem, the Southeast U.S. Continental Shelf Large Marine Ecosystem, and the Gulf Stream Open Ocean Area (specifically within the VACAPES and JAX Range Complexes). The Navy's analysis of the potential for a sea turtle strike is influenced by the following assumptions:

- The model is two-dimensional and assumes that all sea turtles would be at or near the surface 100 percent of the time, when in fact, sea turtles spend most of their time submerged (Renaud and Carpenter 1994; Sasso and Witzell 2006).
- The model assumes the animal is stationary and does not account for any movement of the sea turtle or any potential avoidance of the training or testing activity.

The model does not account for the ability of Navy observers to see and avoid sea turtles. The model also does not account for the fact that most of the projectiles fired during training and testing activities are fired at targets, and most projectiles hit those targets, so only a very small portion of those would hit the water with their maximum velocity and force. The potential of fragments from high-explosive munitions or expended material other than munitions to strike a sea turtle is likely lower than for the worst-case scenario calculated below because those activities happen with much lower frequency. Fragments may include metallic fragments from the exploded target as well as from the exploded ordnance (Table 57).

Table 62. Probability of a Military Expended Materials Strike for a Representative Sea Turtle Species by Area (Ref Table 3.5-17 of the Draft EIS/OEIS)

Northeast United States Continental Shelf Large Marine Ecosystem and Gulf Stream Open Ocean Area		
Virginia Capes (VACAPES) Range Complex		
Species	**Training**	**Testing**
Loggerhead Sea Turtle	1.78%	2.40%
Southeast United States Continental Shelf Large Marine Ecosystem and Gulf Stream Open Ocean Area		
Charleston/Jacksonville (JAX) Range Complex		
Loggerhead Sea Turtle	1.05%	0.26%

Based on these results we conclude that disturbance or direct strike of sea turtles by expended materials is not likely to result from training and testing activities during a given year or during the five year period. As such, we did not assess potential responses as exposure would be unlikely.

6.5.4 Exposure of Fish to Direct Strike from Expended Materials

Based on the primarily nearshore distribution of Atlantic and Gulf sturgeon and overlap of in-water device use, potential strike risk would be greatest in the lower Chesapeake Bay and nearshore waters of the GOMEX Range Complex, although a minor potential exists for strikes of Atlantic and Gulf sturgeon within waters less than 50 to 60 m in depth within any of the ranges.

The likelihood of strikes by towed mine warfare devices on adult or juvenile fish, which could result in injury or mortality, would be extremely low because these life stages are highly mobile. The use of in-water devices may result in short-term and local displacement of fish in the water column. However, these behavioral reactions are not expected to result in substantial changes to an individual's fitness, or species recruitment, and are not expected to result in population-level impacts. Ichthyoplankton (fish eggs and larvae) in the water column could be displaced, injured, or killed by towed mine warfare devices. The numbers of eggs and larvae exposed to vessels or in-water devices would be extremely low relative to total ichthyoplankton biomass (Able and Fahay 1998); therefore, measurable changes on fish recruitment would not occur.

Tthe following categories of military expended materials have potential to affect Atlantic and Gulf Sturgeon: (1) non-explosive practice munitions, (2) fragments from high-explosive munitions, and (3) expended materials other than munitions, such as sonobuoys, vessel hulks, parachutes, fiber optic cables and guidance wires, and expendable targets.

While disturbance or strike from any of these objects as they sink through the water column is possible, it is not very likely for most expended materials because the objects generally sink through the water slowly and can be avoided by most fish including sturgeon. Therefore, with the exception of sinking exercises, the discussion of military expended materials strikes focuses on strikes at the surface or in the upper water column from fragments (of high-explosives) and projectiles because those items have a greater potential for a fish strike as they hit the water, before slowing down as they move through the water column.

Fish disturbance or strike could result from bomb fragments (after explosion) falling through the water column in very small areas compared to the vast expanse of the testing ranges, OPAREAs, range complexes, or the Study Area. The expected reaction of fish exposed to this stressor would be to immediately leave the area where bombing is occurring, thereby reducing the probability of a fish strike after the initial expended materials hit the water surface. When a disturbance of this type concludes, the area would be repopulated and the fish stock would rebound with inconsequential impacts on the resource (Lundquist et al. 2010).

Based on these results we conclude that disturbance or direct strike of Atlantic and Gulf sturgeon and smalltooth sawfish by expended materials is not likely to result from training and testing activities during a given year or during the five year period. As such, we did not assess potential responses as exposure would be unlikely.

6.6 Risk from Exposure to Electromagnetic Devices and Lasers

Naval devices that will produce an electromagnetic field are towed or unmanned mine countermeasure systems. The electromagnetic field is produced to simulate a vessel's magnetic field. In an actual mine clearing operation, the intent is that the electromagnetic field would trigger an enemy mine designed to sense a vessel's magnetic field. The majority of devices involved in the proposed activities would be towed or unmanned mine warfare systems that mimic the electromagnetic signature of a vessel passing through the water. None of the devices include any type of electromagnetic "pulse." An example of a representative device is the Organic Airborne and Surface Influence Sweep that would be used by a MH-60S helicopter at sea. The Organic Airborne and Surface Influence Sweep is towed from a forward flying helicopter and works by emitting an electromagnetic field and mechanically generated underwater sound to simulate the presence of a ship. The sound and electromagnetic signature cause nearby mines to detonate.

Table 63.Number and Location of Events Using Electromagnetic Devices

Activity Area	Training	Testing
VACAPES (W-50, Lower Chesapeake Bay)	0	0
VACAPES (W-50, W-72)	0	0

VACAPES	882	40
Cherry Point (ARG Mine Training Area)	0	0
Cherry Point	185	0
JAX (CSG Mine Training Areas)	0	0
JAX	157	0
SFOMF	0	33
NSWC PCD	0	87
GOMEX	96	0
Gulf of Mexico	0	14
Northeast, VACAPES, Cherry Point, JAX, GOMEX	1	0
Total	**1,321**	**174**

The kinetic energy weapon (commonly referred to as the rail gun) is under development and will likely be tested and eventually used in training events aboard surface vessels, firing non-explosive projectiles at land or sea-based targets. The system uses stored electrical energy to accelerate the projectiles, which are fired at supersonic speeds over great distances. The system charges for two minutes, and fires in less than a second, therefore, any electromagnetic energy released would be done so over a very short period. Also, the system would likely be shielded so as not to affect shipboard controls and systems. The amount of electromagnetic energy released from this system would likely be low and contained on the surface vessel.

The Navy proposes to test the kinetic energy weapon system on vessels in the VACAPES Range Complex (55 events per year) and one time in the AFTT Study Area during the five-year period. This kinetic energy weapon would generate and electromagnetic field (within the railgun barrel) to launch a projectile. Because the electromagnetic field is produced within the railgun barrel, ESA-listed species would not be exposed to the electromagnetic field. Therefore, we do not analyze the risk of this stressor further in this Opinion.

Laser devices can be organized into two categories: (1) low energy lasers and (2) high energy lasers. Low energy lasers are used to illuminate or designate targets, to guide weapons, and to detect or classify mines. High energy lasers are used as weapons to disable surface targets. High energy lasers would be used in the Study Area within the VACAPES Range Complex as part of the Proposed Action; however, we concluded that high energy lasers would have no effect on listed resources and are not discussed further.

6.6.1 Exposure of Cetaceans and Pinnipeds to Electromagnetic Devices and Lasers

Little evidence exists that marine mammals are particularly sensitive to electromagnetic devices, with the exception of the Guiana dolphin (Czech-Damal et al. 2012). Normandeau et al. {, 2011 #155867} reviewed available information on electromagnetic and magnetic field sensitivity of marine organisms (including marine mammals) for impact assessment of offshore wind farms for the Department of Interior and concluded there is no evidence to suggest any magnetic sensitivity for sea lions, fur seals, or sea otters {Normandeau, 2011 #155867}. However, Normandeau et al. {, 2011 #155867} concluded there was behavioral, anatomical, and theoretical evidence indicating cetaceans sense magnetic fields. Most of the evidence in this regard is indirect evidence from correlation of sighting and stranding locations suggesting that cetaceans may be influenced by local variation in the earth's magnetic field (Kirschvink 1990; Klinowska 1985a; Klinowska 1985b; Walker et al. 1992) (Hui 1984). Results from one study in particular showed that long-finned and short-finned pilot whales, striped dolphin, Atlantic spotted dolphin, Atlantic white-sided dolphin, fin whale, common dolphin, harbor porpoise, sperm whale, and pygmy sperm whale were found to strand in areas where the earth's magnetic field was locally weaker than surrounding areas (negative magnetic anomaly) (Kirschvink 1990). Results also indicated that certain species may be able to detect total intensity changes of only 0.05 microtesla (Kirschvink and Walker. 1985). This gives insight into what changes in intensity levels some species are capable of detecting, but does not provide experimental evidence of levels to which animals may physiologically or behaviorally respond.

No evidence for electrosensitivity in marine mammals has been reported. Due to their large size, and other logistical constraints, controlled experiments are not feasible for many cetacean species. However, statistically reliable studies correlating marine mammal behavior with geomagnetic fields have been recorded. Within the Order Cetacea, members from both suborders mysticetes (i.e. fin and humpbacks), and odontocetes (i.e. sperm whales, beaked whales, and multiple species of dolphins, and porpoises), have shown positive correlations with geomagnetic field differences, thus making it more plausible that all members of the Order Cetacea are magneto-sensitive. Because of the nature of such studies, the potential confounding role of other factors could not be tested. Although none of the studies have determined the mechanism for magneto-sensitivity, the suggestion from these studies is that members of the Order Cetacea can sense the Earth's magnetic field and may use it to migrate long distances.

Cetaceans appear to use the Earth's magnetic field for migration in two ways: as a map by moving parallel to the contours of the local field topography, and as a timer based on the regular fluctuations in the field allowing animals to monitor their progress on this map (Kirschvink 1990). Cetaceans do not appear to use the Earth's magnetic field for directional information (Kirschvink 1990).

Potential impacts to marine mammals associated with electromagnetic fields are dependent on the animal's proximity to the source and the strength of the magnetic field. Electromagnetic fields associated with naval training and testing activities are relatively weak (only 10 percent of the earth's magnetic field at 79 ft.), temporary, and localized. Once the source is turned off or moves from the location, the electromagnetic field is gone. A marine mammal would have to be present within the electromagnetic field (approximately 656 ft. [200 m] from the source) during the activity in order to detect it.

Within the category of low energy lasers, the highest potential level of exposure would be from an airborne laser beam directed at the ocean's surface. An assessment on the use of low energy lasers by the Navy determined that low energy lasers, including those involved in the training and testing activities in this EIS/OEIS, have an extremely low potential to impact marine biological resources {Swope, 2010 #155858}. The assessment determined that the maximum potential for laser exposure is at the ocean's surface, where laser intensity is greatest {Swope, 2010 #155858}. As the laser penetrates the water, 96 percent of a laser beam is absorbed, scattered, or otherwise lost {Ulrich, 2004 #155859}. Based on the parameters of the low energy lasers and the behavior and life history of major biological groups, it was determined the greatest potential for impact would be to the eye of a marine mammal or sea turtle. However, an animal's eye would have to be exposed to a direct laser beam for at least 10 seconds or longer to sustain damage. Swope {, 2010 #155858} assessed the potential for damage based on species specific eye/vision parameters and the anticipated output from low energy lasers and determined that no animals were predicted to incur damage. Zorn et al. (Zorn et al. 2000) conducted an analysis of the sensitivity ratio was calculated for each species using the ratio of the irradiance at the retina of the marine mammal to the irradiance at the retina of humans. The sensitivity ratio was used to suggest exposure limits for the various species. They concluded that because the human eye is more sensitive than either the cetacean or pinniped eye, that laser energies that are eye-safe for humans will also be safe for marine mammals, and higher laser irradiances may be permissible if illumination of humans is avoided (Zorn et al. 2000).

Based on these results we conclude that exposure of cetaceans and ringed seals to electromagnetic devices and low energy lasers is not likely to result from training and testing activities during a given year or during the five year period. As such, we did not assess potential responses and exposure would be unlikely.

6.6.2 Exposure of Sea Turtles to Electromagnetic Devices and Lasers

Sea turtles use geomagnetic fields to navigate at sea, and therefore changes in those fields could impact their movement patterns (Lohmann and Lohmann 1996; Lohmann and Lohmann 1998). Turtles in all life stages orient to the earth's magnetic field to position themselves in oceanic currents; this helps them locate seasonal feeding and breeding grounds and to return to their nesting sites (Lohmann and Salmon 1996; Lohmann and Lohmann 1996). Experiments show that sea turtles can detect changes in magnetic fields, which may cause them to deviate from their original direction (Lohmann and Salmon 1996; Lohmann and Lohmann 1996). For example, Lohmann and Lohmann (1996) found that loggerhead hatchlings tested in a magnetic field of 52,000 nanoteslas swam eastward, and when the field was decreased to 43,000 nanoteslas, the hatchlings swam westward. Sea turtles also use nonmagnetic cues for navigation and migration, and these additional cues may compensate for variations in magnetic fields.

If located in the immediate area (within about 650 ft. [200 m]) where electromagnetic devices are being used, sea turtles could deviate from their original movements. The electromagnetic devices used in training activities (Table 63) are not expected to cause more than a short-term behavioral disturbance to sea turtles because of the: (1) relatively low intensity of the magnetic fields generated (0.2 microtesla at 200 m [656.2 ft.] from the source), (2) very localized potential impact area, and (3) temporary duration of the activities (hours). Potential impacts of exposure to electromagnetic stressors are not expected to result in substantial changes to an individual's behavior, growth, survival, annual reproductive success, lifetime reproductive success (fitness), or species recruitment, and are not expected to result in population-level impacts.

Lasers used as part of proposed training and testing activities would be low-energy lasers used for mine detection and targeting. While all points on a sea turtle's body would have roughly the same probability of laser exposure, only eye exposure is of concern for low-energy lasers. Any heat that the laser generates would rapidly dissipate due to the large heat capacity of water and the large volume of water in which the laser is used. There is no suspected effect due to heat from the laser beam. Eye damage to sea turtles is unlikely because eye damage depends on wavelength with exposures of greater than 10 seconds. With pulse durations less than 10 seconds, combined with the laser platform movement and animal motion, exposures of more than 10 seconds would not be possible. Furthermore, 96 percent of a laser beam projected into the ocean is absorbed, scattered, or otherwise lost (Guenther et al. 1996). Therefore, the use of low-energy lasers is discounted from the analysis of potential impacts on sea turtles.

Based on these results we conclude that exposure of sea turtles to electromagnetic devices and low energy lasers is not likely to result from training and testing activities during a given year or during the five year period. As such, we did not assess potential responses and exposure would be unlikely.

6.6.3 Exposure of Fish to Electromagnetic Devices and Lasers

ESA-listed species that occur within areas that electromagnetic devices and lasers may be used include smalltooth sawfish, Atlantic sturgeon and Gulf sturgeon and as such would have the potential to be exposed to electromagnetic devices.

Sturgeon and smalltooth sawfish would likely be able to detect electromagnetic energy in the water column (Bullock et al. 1983; Helfman et al. 2009) if exposed. Exposure of electromagnetically sensitive fish species to electromagnetic activities has the potential to result in stress to the animal and may also elicit alterations in normal behavior patterns (e.g., swimming, feeding, resting, and spawning).

Smalltooth sawfish and Atlantic occur in training and testing areas. Smalltooth sawfish could occur in the JAX Range Complex, but any occurrences would be extremely rare (Florida Museum of Natural History 2011). Atlantic sturgeon inhabit shallow nearshore and coastal waters, and therefore, may encounter electromagnetic devices used in training activities in the lower Chesapeake Bay. Other locations include portions of the range complexes that lie within the continental shelf, overlapping the normal distribution of Atlantic sturgeon, shortnose sturgeon, and smalltooth sawfish. The electromagnetic devices used in training and testing activities would not cause any risk to smalltooth sawfish and Atlantic sturgeon because of the: (1) relatively low intensity of the magnetic fields generated (0.2 microtesla at 656 ft. [200 m] from the source), (2) highly localized potential impact area, and (3) limited and temporally distinct duration of the activities (hours).

Electromagnetic devices would not result in impacts on the primary constituent elements of critical habitat for Atlantic salmon or smalltooth sawfish. The electromagnetic activities at Naval Surface Warfare Center, Panama City Division Testing Range could overlap with Gulf sturgeon critical habitat. Any effects on the primary constituent elements of Gulf sturgeon critical habitat would be discountable because the food sources identified as primary constituent elements of the critical habitat that occur in the Naval Surface Warfare Center, Panama City Division Testing Range would not be impacted by this activity.

Fish species that do not occur within the VACAPES Range Complex or that do not occur near the sea surface including smalltooth sawfish, and Gulf sturgeon would not be exposed to high energy lasers. It is very unlikely that an individual would surface at the exact moment in the exact place that the laser hit the surface. Fish are unlikely to be exposed to high energy lasers based on: the (1) relatively low number of events, (2) very localized potential impact area of the laser beam, and (3) temporary duration of potential impact (seconds).

Based on these results we conclude that exposure of Atlantic and Gulf sturgeon and smalltooth sawfish to electromagnetic devices and low energy lasers is not likely to result from training and testing activities during a given year or during the five year period. As such, we did not assess potential responses and exposure would be unlikely.

6.7 Overview of Risk Analyses for Effects of Acoustic Stressors on ESA Species

The addition of sound to the marine environment is recognized as a potential risk to by the scientific community, that could possibly harm marine mammals or significantly interfere with their normal activities (NRC 2005a). Assessing whether a sound may disturb or injure a marine mammal involves understanding the characteristics of the acoustic sources, the marine mammals that may be present in the vicinity of the sound, and the effects that sound may have on the physiology and behavior of those marine mammals. Although it is known that sound is important for marine mammal communication, navigation, and foraging (NRC 2005a), there are many unknowns in assessing impacts such as the potential interaction of different effects and the significance of responses by marine mammals to sound exposures (Nowacek et al. 2007; Southall et al. 2007a). Recent studies (Clark and Schick 2012) (Costa 2012) on population-level impats as part of a broader effort by the Navy (PCAD) help us understand how individual-level effects translate to population and species-level impacts. Other studies such as (David 2012) (Deruiter et al. 2013) (Goldbogen et al. 2013) (Doksaeter et al. 2012) (Fleishman 2012) (Francis and Barber 2013) provide further insight on potential responses of marine mammals to sound in the water from vessels and in-air sounds such as explosions (Demarchi et al. 2012).

6.7.1 Use of the Navy Acoustic Effects Model (NAEMO) in Marine Mammal and Sea Turtle Exposure Analysis

Prior to the initiation of formal ESA consultation NMFS worked with Navy as they developed a new modeling approach to estimate the number of marine mammals that might be exposed during their training and testing activities. This effort culminated in the Navy's Acoustic Effects Model (NAEMO). Below we provide a brief description of the NAEMO; a more expansive description is provided in the Navy's Final EIS/OEIS.

The Navy developed a set of software tools and compiled data for estimating acoustic effects on marine mammals without consideration of behavioral avoidance or Navy's standard mitigations. These databases and tools collectively form the Navy Acoustic Effects Model (NAEMO). The Navy Acoustic Effects Model improves upon previous modeling efforts in several ways. First, unlike earlier methods that modeled sources individually, the Navy Acoustic Effects Model has the capability to run all sources within a scenario simultaneously, providing a more realistic depiction of the potential effects of an activity. Second, previous models calculated sound received levels within set volumes of water and spread animals uniformly across the volumes; in the Navy Acoustic Effects Model, animats (virtual animals) are distributed non-uniformly based on higher resolution species-specific density, depth distribution, and group size, and animats serve as dosimeters, recording energy received at their location in the water column. Third, a fully three-dimensional environment is used for calculating sound propagation and animat exposure in the Navy Acoustic Effects Model, rather than a two-dimensional environment where the worst case sound pressure level across the water column is always encountered. Finally, current efforts incorporate site-specific bathymetry, sound speed profiles, wind speed, and bottom properties into the propagation modeling process rather than the flat-bottomed provinces used during earlier modeling (NUWC 2012). The following paragraphs provide an overview of the Navy Acoustic Effects Model process and its more critical data inputs.

Using the best available information on the predicted density of marine mammals in the area being modeled, the Navy Acoustic Effects Model derives an abundance (total number of individuals) and distributes the resulting number of animats into an area bounded by the maximum distance that energy propagates out to a criterion threshold value (energy footprint). For example, for non-impulsive sources, all animats that are predicted to occur within a range that could receive sound pressure levels greater than or equal to 120 dB sound pressure level are distributed. These animats are distributed based on density differences across the area, the group (pod) size, and known depth distributions (dive profiles) (see (Marine Species Modeling Team 2012b)) for a discussion of animal dive profiles in detail). Animats change depths every 4 minutes but do not otherwise mimic actual animal behaviors, such as avoidance or attraction to a stimulus (horizontal movement), or foraging, social, or traveling behaviors.

Schecklman et al. (2011) argue that static distributions underestimate acoustic exposure compared to a model with fully three-dimensionally moving animals. However, their static method is different from the Navy Acoustic Effects Model in several ways. First, they distribute the entire population at depth with respect to the species-typical depth distribution histogram, and those animats remain static at that position throughout the entire simulation. In the Navy Acoustic Effects Model, animats are placed horizontally dependent on non-uniform density information, and then move up and down over time within the water column by integrating species-typical depth distribution information. Second, for the static method they calculate acoustic received level for designated volumes of the ocean and then sum the animats that occur within that volume, rather than using the animats themselves as dosimeters, as in the Navy Acoustic Effects Model. Third, Schecklman et al. (2011) ran 50 iterations of the moving distribution to arrive at an average number of exposures, but because they rely on uniform horizontal density (and static depth density), only a single iteration of the static distribution is realized. In addition to moving the animats vertically, the Navy Acoustic Effects Model overpopulates the animats over a non-uniform density and then resamples the population a number of times to arrive at an average number of exposures as well. Tests comparing fully moving distributions and static distributions with vertical position changes at varying rates were compared during development of the Navy Acoustic Effects Model. For position updates occurring more frequently than every 5 minutes, the number of estimated exposures was similar between the Navy Acoustic Effects Model and the fully moving distribution; however, computational time was much longer for the fully moving distribution.

The Navy Acoustic Effects Model calculates the likely propagation for various levels of energy (sound or pressure) resulting from each non-impulse or impulse source used during a training or testing event. This is done by taking into account the actual bathymetric relief and bottom types (e.g., reflective), and estimated sound speeds and sea surface roughness at an event's location. Platforms (such as a ship using one or more sound sources) are modeled as moving across an area whose size is representative of what would normally occur during a training or testing scenario. The model uses typical platform speeds and event durations. Moving source platforms either travel along a predefined track or move along straight-line tracks from a random initial course, reflecting at the edges of a predefined boundary. Static sound sources are stationary in a fixed location for the duration of a scenario. Modeling locations were chosen based on historical data where activities have been ongoing and in an effort to include as much environmental variation within the AFTT Study Area as is reasonably available and can be incorporated into the model.

The Navy Acoustic Effects Model then records the energy received by each animat within the energy footprint of the event and calculates the number of animats having received levels of energy exposures that fall within defined impact thresholds.

Predicted effects on the animats within a scenario are then tallied and the highest order effect (based on severity of criteria; e.g., PTS over TTS) predicted for a given animat is assumed. Each scenario or each 24-hour period for scenarios lasting greater than 24 hours is independent of all others, and therefore, the same individual marine animal could be impacted during each independent scenario or 24-hour period. In few instances, although the activities themselves all occur within the AFTT Study Area, sound may propagate beyond the boundary of the Study Area. Any exposures occurring outside the boundary of the Study Area are counted as if they occurred within the Study Area boundary. The Navy Acoustic Effects Model provides the initial estimated impacts on marine species with a static horizontal distribution.

Model Assumptions- There are limitations to the data used in the model, and the results must be interpreted within these context. While the most accurate data and input assumptions have been used in the modeling, when there is a lack of definitive data to support an aspect of the modeling, modeling assumptions believed to overestimate the number of exposures have been chosen:

Animats are modeled as being underwater, stationary, and facing the source and therefore always predicted to receive the maximum sound level (i.e., no porpoising or pinnipeds' heads above water). Some odontocetes have been shown to have directional hearing, with best hearing sensitivity facing a sound source and higher hearing thresholds for sounds propagating towards the rear or side of an animal (Kastelein et al. 2005c; Mooney et al. 2008b; Popov and Supin. 2009).

Animats do not move horizontally (but change their position vertically within the water column), which may overestimate physiological effects such as hearing loss, especially for slow moving or stationary sound sources in the model.

Animats are stationary horizontally and therefore do not avoid the sound source, unlike in the wild where animals would most often avoid exposures at higher sound levels, especially those exposures that may result in PTS.

Animats are assumed to receive the full impulse of the initial positive pressure wave due to an explosion, although the impulse-based thresholds (onset mortality and onset slight lung injury)

assume an impulse delivery time adjusted for animal size and depth. Therefore, these impacts are overestimated at farther distances and increased depths.
Multiple exposures within any 24-hour period are considered one continuous exposure for the purposes of calculating the temporary or permanent hearing loss, because there are not sufficient data to estimate a hearing recovery function for the time between exposures.
Mitigation measures that are implemented during many training and testing activities were not considered in the model. In reality, sound-producing activities would be reduced, stopped, or delayed if marine mammals are detected within the mitigation zones around sound sources.

An animal is considered "exposed" to a sound if the received sound level at the animal's location is within the frequency band of the functional hearing group (cetacean, pinniped, etc.) at a level that could be heard. There are two primary types of source classes: impulsive and non-impulsive.

To conduct an exposure analysis, the acoustic sources were divided into categories (bins) based on sound characteristics. Impulsive bins are based on the net explosive weight of the munitions or explosive devices or the source level for air and water guns. Non-impulsive acoustic sources are grouped into bins based on the frequency, source level, and when warranted, the application in which the source would be used. The following factors further describe the considerations associated with the development of non-impulsive source bins:

Frequency of the non-impulsive source:

- Low-frequency sources operate below 1 kilohertz (kHz)
- Mid-frequency sources operate at and above 1 kHz, up to and including 10 kHz
- High-frequency sources operate above 10 kHz, up to and including 100 kHz
- Very high-frequency sources operate above 100 kHz but below 200 kHz

Source level of the non-impulsive source:

- Greater than 160 dB, but less than 180 dB
- Equal to 180 dB and up to 200 dB
- Greater than 200 dB

Application in which the source would be used:

- How a sensor is employed supports how the sensor's acoustic emissions are
- analyzed.
- Factors considered include pulse length (time source is on); beam pattern
- (whether sound is emitted as a narrow, focused beam or, as with most explosives, in
- all directions); and duty cycle (how often or how many times a transmission occurs in a given time period during an event).

For this ESA consultation, we considered exposure estimates from the Navy Acoustic Effects Model at two output points. First, the total number of animats representing ESA-listed species that would be exposed to acoustic sources prior to the application of a dose-response curve or criteria. We term these the unprocessed or "raw exposure" estimates. This estimate is the number of times individual animals are likely to be exposed to the acoustic environment that is a result of training and testing activities, regardless of whether they are "taken" as a result of that exposure. In most cases, the number of animals "taken" by an action would be a subset of the number of animals that are exposed to the action because (1) in some circumstances, animals might not respond to an exposure and (2) some responses may be adverse for an individual animal without constituting a form of "take" (for example, some physiological stress responses only have fitness consequences when they are sustained and would only constitute a "take" as a result of cumulative exposure).

A second set of exposure estimates of listed species were generated and "processed" using dose-response curves and criteria for temporary and permanent threshold shift developed by the Navy and NMFS' Permits Division. Neither sets of exposure estimates, the unprocessed or processed, consider standard mitigation actions that the Navy proposes or NMFS Permits Division would require under the MMPA rule to avoid marine mammals or sea turtles, nor did the estimates consider any avoidance responses that might be taken by individual animals once they sense the presence of Navy vessels or aircraft.

Lastly, the U.S. Navy applied a third step of incorporated species specific avoidance and mitigation to derive the Navy's final MMPA take request. The analysis presented in this Opinion considers all three exposure estimates on an annual basis, cumulatively over five years and cumulatively for the reasonably foreseeable future as training and testing activities are assumed to continue at levels similar to those assessed in this opinion.

Acoustic impacts presented are the total number of exposures and not necessarily the number of individuals exposed. An animal could receive more than one exposure and associated acoustic impact over the course of an event or within a given year.

6.7.1.1 ***Marine Mammal Abundance and Densities Used in NAEMO***

There is no single source of density data for every area of the world, species, and season because of the fiscal costs, resources, and effort involved in providing survey coverage to sufficiently estimate density. To characterize the marine species density in NAEMO for large areas such as the AFTT Study Area, the Navy compiled data from several sources. To compile and structure the most appropriate database of marine species density data, the Navy developed a protocol to select the best available data sources based on species, area, and time (season). The resulting Geographic Information System database called the Navy Marine Species Density Database includes seasonal density values for every marine mammal and sea turtle species present within the Study Area (U.S. Department of the Navy 2012).

The Navy Marine Species Density Database includes a compilation of the best available density data from several primary sources and published works including survey data from NMFS within the U.S. Exclusive Economic Zone. In this analysis, marine mammal density data were used as an input in NAEMO in their original temporal (seasonal) and spatial resolution. Seasons are defined as winter (December–February), spring (March–May), summer (June–August), and fall (September– November). The density grid cell spatial resolution varied, depending on the original data source used, from 10 km^2 to 0.5 $degrees^2$ (latitude/longitude). Where data sources overlap, there might be a sudden increase or decrease in density due to different derivation methods or survey data utilized. This is an artifact of attempting to use the best available data for each geographic region. The density data were used as-is in order to preserve the original values. Any attempt to smooth the data sets would either increase or decrease adjacent values and would inflate the error of those values by an unknown amount.

6.7.1.2 *Sea Turtle Densities Used in NAEMO*

In this analysis, sea turtle density data were used as an input in the Navy Acoustic Effects Model in their original temporal and spatial resolution. Seasons are defined as winter (December – February), spring (March – May), summer (June – August), and fall (September – November). The density grid cell spatial resolution varied, depending on the original data source utilized. Where data sources overlap, there might be a sudden increase or decrease in density due to different derivation methods or survey data utilized. This is an artifact of attempting to use the best available data for each geographic region. Any attempt to smooth the datasets would either increase or decrease adjacent values and would inflate the error of those values. The density data used for the quantitative analysis of acoustic impacts on sea turtles comes from the Navy Operating Area (OPAREA) density report and are primarily based on NMFS aerial survey data collected along the U.S. east coast. The aerial surveys covered only a limited coastal area of the U.S. Exclusive Economic Zone.

To estimate density beyond the survey coverage area, the farthest offshore Navy OPAREA density report density data were extrapolated to the extent of the U.S. Exclusive Economic Zone. To capture the latitudinal variability in sea turtle abundance, the Navy computed the mean density per each remaining OPAREA region not covered by the aerial surveys. Turtle density was determined for each species. Sightings of unknown hardshell species were combined and counted under the species group name hardshell turtles. Hardshell turtles comprise unknown sea turtle sightings that could be a mix of Kemp's ridley, olive ridley, hawksbill, loggerhead, and green sea turtles; green turtles are only considered under the hardshell turtle category because this species does not have a separate density estimate. The olive ridley sea turtle will not be analyzed because its occurrence in the Study Area is extralimital. For further explanation, see the Navy Marine Species Density Database technical report (U.S. Department of the Navy 2012).

6.7.2 **Overview of Acoustic Criteria for Exposure and Response Analyses**

The U.S. Navy grouped approximately 300 individual sources of underwater acoustic sound or explosive energy, into a series of source classifications, or source bins. There are two primary types of source classes: "Impulsive" and "Non-impulsive" acoustic. A description of each source classification analyzed for marine mammals is provided in Table 64 and Table 65 below.

Table 64. Training and Testing Non-Impulsive Acoustic Sources Analyzed for Marine Mammals

Source Class Category	Source Class	Description
Low-Frequency (LF): Sources that produce low-frequency (less than 1 kHz) signals.	LF3	Low-frequency sources greater than 200 dB
	LF4	Low-frequency sources equal to 180 dB and up to 200 dB
	LF5	Low-frequency sources greater than 160 dB, but less than 180 dB
	LF6	Low-frequency sonars currently in development (e.g., antisubmarine warfare sonars associated with the Littoral Combat Ship)

Mid-Frequency (MF): Tactical and non-tactical sources that produce mid-frequency (1 to 10 kHz) signals.	MF1	Hull-mounted surface ship sonars (e.g., AN/SQS-53C and AN/SQS-61)
	MF1K	Kingfisher mode associated with MF1 sonars
	MF2	Hull-mounted surface ship sonars (e.g., AN/SQS-56)
	MF2K	Kingfisher mode associated with MF2 sonars
	MF3	Hull-mounted submarine sonars (e.g., AN/BQQ-10)
	MF4	Helicopter-deployed dipping sonars (e.g., AN/AQS-22 and AN/AQS-13)
	MF5	Active acoustic sonobuoys (e.g., DICASS)
	MF6	Active underwater sound signal devices (e.g., MK 84)
	MF8	Active sources (greater than 200 dB) not otherwise binned
	MF9	Active sources (equal to 180 dB and up to 200 dB) not otherwise binned
	MF10	Active sources (greater than 160 dB, but less than 180 dB) not otherwise binned
	MF11	Hull-mounted surface ship sonars with an active duty cycle greater than 80%
	MF12	Towed array surface ship sonars with an active duty cycle greater than 80%
High-Frequency (HF): Tactical and non-tactical sources that produce high-frequency (greater than 10 kHz but less than 200 kHz) signals.	HF1	Hull-mounted submarine sonars (e.g., AN/BQQ-10)
	HF2	High-frequency Marine Mammal Monitoring System
	HF3	Other hull-mounted submarine sonars (classified)
	HF4	Mine detection and classification sonar (e.g., AN/AQS-20)
	HF5	Active sources (greater than 200 dB) not otherwise binned
	HF6	Active sources (equal to 180 dB and up to 200 dB) not otherwise binned
	HF7	Active sources (greater than 160 dB, but less than 180 dB) not otherwise binned
	HF8	Hull-mounted surface ship sonars (e.g., AN/SQS-61)
Anti-Submarine Warfare (ASW): Tactical sources such as active sonobuoys and acoustic countermeasures systems used during the conduct of anti-submarine warfare training and testing activities.	ASW1	Mid-frequency Deep Water Active Distributed System (DWADS)
	ASW2	Mid-frequency Multistatic Active Coherent sonobuoy (e.g., AN/SSQ-125)
	ASW3	Mid-frequency towed active acoustic countermeasure systems (e.g., AN/SLQ-25)
	ASW4	Mid-frequency expendable active acoustic device countermeasures (e.g., MK 3)
Torpedoes (TORP): Source classes associated with the active acoustic signals produced by torpedoes.	TORP1	Lightweight torpedo (e.g., MK 46, MK 54, or Anti-Torpedo Torpedo)
	TORP2	Heavyweight torpedo (e.g., MK 48)
Doppler Sonars (DS): Sonars that use the Doppler effect to aid in navigation or collect oceanographic information.	DS1	Low-frequency Doppler sonar (e.g., Webb Tomography Source)
Forward Looking Sonar (FLS): Forward or upward looking object avoidance sonars.	FLS2 - FLS3	High-frequency sources with short pulse lengths, narrow beam widths, and focused beam patterns used for navigation and safety of ships
Acoustic Modems (M): Systems used to transmit data acoustically through the water.	M3	Mid-frequency acoustic modems (greater than 190 dB)
Swimmer Detection Sonars (SD):	SD1 - SD2	High-frequency sources with short pulse lengths, used for

Systems used to detect divers and submerged swimmers.		detection of swimmers and other objects for the purposes of port security
Airguns (AG): Underwater airguns used during swimmer defense and diver deterrent training and testing activities.	AG	Up to 60 cubic inch airguns (e.g., Sercel Mini-G)
Synthetic Aperture Sonars (SAS): Sonars in which active acoustic signals are post-processed to form high-resolution images of the seafloor.	SAS1	MF SAS systems
	SAS2	HF SAS systems
	SAS3	VHF SAS systems

Table 65. Training and Testing Explosive Sources Analyzed for Marine Mammals

Source Class	**Representative Munitions**	**Net Explosive Weight (NEW) (lb.)**
E1	Medium-caliber projectiles	0.1-0.25
E2	Medium-caliber projectiles	0.26-0.5
E3	Large-caliber projectiles	0.6-2.5
E4	Improved extended echo ranging sonobuoy	2.6-5
E5	5-in. projectiles	6-10
E6	15 lb. shaped charge	11-20
E7	40 demo block/shaped charge	21-60
E8	250 lb. bomb	61-100
E9	500 lb. bomb	101-250
E10	1,000 lb. bomb	251-500
E11	650 lb. mine	501-650
E12	2,000 lb. bomb	651-1,000
E13	1,200 lb. HBX[2] charge	1,001-1,740
E14	2,500 lb. HBX charge	1,741-3,625
E15	5,000 lb. HBX charge	3,626-7,250
E16	10,000 lb. HBX charge	7,251-14,500
E17	40,000 lb. HBX charge	14,501-58,000

1 **Net Explosive Weight refers to the amount of explosives; the actual weight of a munition may be larger due to other components**

2 **HBX: High Blast Explosive family of binary explosives composed of Royal Demolition Explosive (RDX) (explosive nitroamine), TNT, powdered aluminum, and D-2 wax with calcium chloride**

Activities and acoustic source classes modeled for sea turtles are provide in the table below:

Table 66. Activities and Active Acoustic Sources Modeled and Quantitatively Analyzed by the U.S. Navy for Acoustic Impacts on Sea Turtles (Reference FEIS/OEIS

Activity	**Acoustic Source Class[1]**
Training Activities	
ASW for Joint Task Force Exercise (JTFEX)	ASW2
ASW for Composite Training Unit Exercise (COMPTUEX)	ASW2
Group Sail	ASW2
TRACKEX/TORPEX-Surface	ASW1, MF12
TRACKEX-Maritime Patrol Aircraft	ASW2
Testing Activities	
ASW Tracking Test: Maritime Patrol Aircraft	ASW2

Surface Combatant Sea Trials: ASW Testing	MF9, MF10
Surface Combatant Sea Trials: Pierside Sonar Testing	MF9, MF10
Submarine Sea Trial: ASW Testing	MF10
Littoral Combat Ship Mission Package Testing: ASW	LF6, MF12
Surface Ship Sonar Testing/Maintenance	MF9, MF10
UUV Demonstrations (NSWC PCD)	LF4, MF9
Special Warfare Testing (NSWC PCD)	MF9
Stationary Source Testing (NSWC PCD)	LF4, MF8
Towed Equipment Testing(NUWCDIVNPT)	LF4, MF, SAS1
Unmanned Underwater Vehicle (UUV) (NUWCDIVNPT)	LF5
Semi-Stationary Equipment Testing (NUWCDIVNPT)	LF4, LF5, MF9, MF10
UUV Demonstration (NUWCDIVNPT)	LF4, MF9
Signature Analysis Activities (SFOMF)	LF4, ASW2
Surface Testing Activities (SFOMF)	LF5, MF9
UUV Demonstrations (SFOMF)	LF4, MF9
Sonobuoy Lot Acceptance Testing	ASW2
Pierside Integrated Swimmer Defense Testing	LF4, MF8
Unmanned Vehicle Development and Payload Testing	MF9
Special Warfare	MF9

6.7.2.1 *Non-Impulsive Acoustic Source Criteria*

Criteria for physiological effects from sonar and other active acoustic sources are based on TTS and PTS with thresholds based on cumulative sound exposure levels. The onset of TTS or PTS from exposure to underwater explosions is predicted using sound exposure level-based thresholds in conjunction with peak pressure thresholds. The horizontal ranges are then compared, with the threshold producing the longest range being the one used to predict effects. For multiple exposures within any 24-hour period, the received sound exposure level for individual events are accumulated for each marine mammal.

Since no studies have been designed to intentionally induce PTS in marine mammals, onset-PTS levels for these animals must be estimated using empirical TTS data obtained in marine mammals and relationships between TTS and PTS established in terrestrial mammals.

TTS and PTS thresholds are based on TTS onset values for impulsive and non-impulsive sounds obtained from representative species of mid- and high-frequency cetaceans and pinnipeds. These data are then extended to the other marine mammals for which data are not available. The Criteria and Thresholds for Navy Acoustic Effects Analysis Technical Report (Finneran and Jenkins 2012) provides a detailed explanation of the selection of criteria and derivation of thresholds for temporary and permanent hearing loss for marine mammals. Table 67 and Table 68 below provide a summary of non-impulsive acoustic thresholds for TTS and PTS for marine mammals.

Table 67. Acoustic Criteria and Tresholds for Predicting Physiological Effects on Marine Mammals from Sonar and Other Active Acoustic Sources

Group	Species	Physiological	
		Onset TTS	Onset PTS
Low-Frequency Cetaceans Group	All mysticetes	178 dB re 1μPa2-s (low-freq weighting)	198 dB re 1μPa2-s (low-freq weighting)

Mid-Frequency Cetaceans	Dolphins, beaked whales, and medium and large toothed whales	178 dB re 1μPa2-s (mid-freq weighting)	198 dB re 1μPa2-s (mid-freq weighting)
High-Frequency Cetaceans	Harbor porpoise and *Kogia* spp.	152 dB re 1μPa2-s (high-freq weighting)	172 dB re 1μPa2-s (high-freq weighting)
Phocid Seals (In-Water)	Harbor, bearded, hooded common, spotted, ringed, harp, ribbon, & gray seals	183 dB re 1μPa2-s (phocid weighting)	197 dB re 1μPa2-s (phocid weighting)

Pinniped TTS criteria are based on data provided by Kastak et al. (2005) for representative species of both of the pinniped hearing groups: harbor seals (Phocidae) and California sea lions (Otariidae and Odobenidae). Kastak et al. (2005) used octave band noise centered at 2.5 kHz to extrapolate an onset TTS threshold. More recently Kastelein et al. (2012) used octave band noise centered at 4 kHz to obtain TTS thresholds in the same two species resulting in similar levels causing onset-TTS as those found in Kastak et al. (2005). Based on similarities of manatee hearing ranges (Gerstein et al. 1999) to phocid seal hearing ranges, the phocid TTS threshold is applied to manatees.

The appropriate frequency weighting function for each species group is applied when using the sound exposure level-based thresholds to predict TTS.

Table 68. Criteria and Thresholds for Predicting Physiological Effects on Marine Mammals from Explosions

Group	Species	Onset TTS	Onset PTS	Onset Slight GI Tract Injury	Onset Slight Lung Injury	Onset Mortality
Low-Frequency Cetaceans	Mysticetes	172 dB re 1 μPa^{2}-s (low-freq weighting) or 224 dB Peak SPL	187 dB re 1 μPa^{2}-s (low-freq weighting) or 230 dB Peak SPL	237 dB re 1 μPa	Equation 1	Equation 2
Mid-Frequency Cetaceans	Odontocetes (Toothed Whales)	172 dB re 1 μPa^{2}-s (mid-freq weighting) or 224 dB Peak SPL	187 dB re 1 μPa^{2}-s (mid-freq weighting) or 230 dB Peak SPL			
High-Frequency Cetaceans	Porpoises and *Kogia* spp.	146 dB re 1 μPa^{2}-s (mid-freq weighting) or 195 dB Peak SPL	161 dB re 1 μPa^{2}-s (mid-freq weighting) or 201 dB Peak SPL			
Phocid Seals (In-Water)	Harbor, beared, hooded common, spotted, ringed, harp,	177 dB re 1 μPa^{2}-s (phocid weighting) or 212 dB Peak SPL	192 dB re 1 μPa^{2}-s (phocid weighting) or 218 dB Peak SPL			

	ribbon and gray seals					

Equations:

(1) $= 39.1M^{1/3}\left(1+\frac{D_{Rm}}{10.081}\right)^{1/2} Pa-sec$

(2) $= 91.4M^{1/3}\left(1+\frac{D_{Rm}}{10.081}\right)^{1/2} Pa-sec$

D_{rm} = depth of the receiver (animal) in meters; M = mass of the animals in kg; SPL = sound pressure level

In this Opinion, we consider two primary categories of sound sources that the U.S. Navy used in its analyses of sound impacts on sea turtles: impulsive sources (e.g., explosives, airguns, weapons firing) and non-impulsive sources (e.g., sonar, pingers, and countermeasure devices). Acoustic impacts criteria and thresholds were developed in cooperation with NMFS for sea turtle exposures to various sound sources. These acoustic impacts criteria are summarized in Table 69 below. These criteria can be used to estimate the number of sea turtles impacted by testing and training activities that emit sound or explosive energy, as well as the severity of the immediate impacts. These criteria are used to quantify impacts from explosives, swimmer defense airguns, sonar, and other active acoustic sources. These criteria are also useful for qualitatively assessing activities that indirectly impart sound to water, such as firing of weapons and aircraft flights.

Table 69. Sea Turtle Impact Threshold Criteria for Non-Impulse Sources (Reference FEIS/OEIS)

Physiological Thresholds	
Onset PTS	**Onset TTS**
198 dB SEL (T)	**178 dB SEL (T)**

dB: decibels; µPa: micropascals; PTS: permanent threshold shift; SEL: sound exposure level; SPL: sound pressure level; TTS: temporary threshold shift; (T): Turtle weighting function

6.7.2.2 *Criteria for Mortality and Slight Lung Injury*

In air or submerged, the most commonly reported internal bodily injury due to explosive detonations is hemorrhaging in the fine structure of the lungs. The likelihood of internal bodily injury is related to the received impulse of the underwater blast (pressure integrated over time), not peak pressure or energy (Richmond et al. 1973b; Yelverton and Richmond 1981; Yelverton et al. 1973b; Yelverton et al. 1975b). Therefore, impulse is used as a metric upon which internal organ injury can be predicted. Onset mortality and onset slight lung injury are defined as the impulse level that would result in 1 percent mortality (most survivors have moderate blast injuries and should survive) and zero percent mortality (recoverable, slight blast injuries) in the exposed population, respectively. Criteria for onset mortality and onset slight lung injury were developed using data from explosive impacts on mammals (Yelverton and Richmond 1981).

The impulse required to cause lung damage is related to the volume of the lungs. The lung volume is related to both the size (mass) of the animal and compression of gas-filled spaces at increasing water depth. Turtles have relatively low lung volume to body mass and a relatively stronger anatomical structure compared to mammals; therefore, application of the criteria derived from studies of impacts of explosives on mammals is conservative.

6.7.2.2.1 Sea Turtles

Table 70 provides a nominal conservative body mass for each sea turtle species based on juvenile mass. Juvenile body masses were selected for analysis given the early rapid growth of these reptiles (newborn turtles weigh less than 0.5 percent of maximum adult body mass). In addition, small turtles tend to remain at shallow depths in the surface pressure release zone, reducing potential exposure to injurious impulses. Therefore, use of hatchling weight would provide unrealistically low thresholds for estimating injury to sea turtles. The use of juvenile body mass rather than hatchling body mass was chosen to produce reasonably conservative estimates of injury.

The scaling of lung volume to depth is conducted for all species since data come from experiments with terrestrial animals held near the water's surface. The calculation of impulse thresholds consider depth of the animal to account for compression of gas-filled spaces that are most sensitive to impulse injury. The impulse required for a specific level of injury (impulse tolerance) is assumed to increase proportionally to the square root of the ratio of the combined atmospheric and hydrostatic pressures at a specific depth with the atmospheric pressure at the surface (Goertner 1982). Additionally, to reach the threshold for onset slight lung injury or onset mortality, the critical impulse value must be delivered during a time period that is the lesser of either the initial positive pressure duration or 20 percent of the natural period of the assumed-spherical lung adjusted for size and depth of the animal. Therefore, as depth increases or animal size decreases, impulse delivery time decreases (Goertner 1982).

Very little information exists regarding the impacts of underwater detonations on sea turtles. Impacts on sea turtles from explosive removal operations range from noninjurious impacts (e.g., acoustic annoyance, mild tactile detection, or physical discomfort) to varying levels of injury (i.e., nonlethal and lethal injuries) (e.g., Klima et al. 1988a; Viada et al. 2008). Often, impacts of explosive events on turtles must be inferred from documented impacts on other vertebrates with lungs or other-gas containing organs, such as mammals and most fishes (Viada et al. 2008). The methods used by Goertner (1982) to develop lung injury criteria for marine mammals may not be directly applicable to sea turtles, as it is not known what degree of protection to internal organs from the shock waves is provided to sea turtles by their shell (Viada et al. 2008). However, the general principles of the Goertner model are applicable and should provide a protective approach to assessing potential impacts on sea turtles. The Goertner method predicts a minimum primary positive impulse value associated with onset of slight lung injury and onset of mortality, adjusted for assumed lung volume (correlated to animal mass) and depth of the animal. These equations are shown in Table 71.

Table 70. Species-Specific Sea Turtle Masses for Determining Onset of Extensive and Slight Lung Injury Thresholds

Common Name	Juvenile Mass (kg)	Reference
Loggerhead sea turtle	8.4	Southwood et al. (2007)
Green sea turtle	8.7	Wood and Wood (1993)

Hawksbill sea turtle	7.4	Okuyama et al. (2010)
Kemp's ridley sea turtle	6.3	McVey and Wibbels (1984) and Caillouet (1986)
Leatherback sea turtle	34.8	Jones (2009)

6.7.2.3 *Criteria for Onset of Gastrointestinal Tract Injury*

Without data specific to sea turtles, data from tests with terrestrial animals are used to predict onset of gastrointestinal tract injury. It is shown that gas-containing internal organs, such as lungs and intestines, were the principle damage sites from shock waves in submerged terrestrial mammals (Clark and Ward 1943; Greaves et al. 1943; Richmond et al. 1973b; Yelverton et al. 1973b). Furthermore, slight injury to the gastrointestinal tract may be related to the magnitude of the peak shock wave pressure over the hydrostatic pressure and would be independent of the animal's size and mass (Goertner 1982). Slight contusions to the gastrointestinal tract were reported during small charge tests (Richmond et al. 1973b), when the peak was 237 dB re 1 µPa. Therefore, this value is used to predict onset of gastrointestinal tract injury in sea turtles exposed to explosions.

Table 71. Sea Turtle Impact Threshold Criteria for Impulsive Sources

Impulsive Sound Exposure Impact	Threshold Value
Onset Mortality[1] (1% Mortality Based on Extensive Lung Injury)	$= 91.4M^{1/3}\left(1+\frac{D_{Rm}}{10.081}\right)^{1}/_{2}\ Pa-s$
Onset Slight Lung Injury[1]	$= 39.1M^{1/3}\left(1+\frac{D_{Rm}}{10.081}\right)^{1}/_{2}\ Pa-s$
Onset Slight Gastrointestinal Tract Injury	237 dB re 1 µPa SPL (104 psi)
Onset PTS	187 dB re 1 µPa^2 - s SEL (T[2]) or 230 dB re 1 µPa Peak SPL
Onset TTS	172 dB re 1 µPa^2 - s SEL (T[2]) or 224 dB re 1 µPa Peak SPL
Injury (Airguns)	190 dB re 1 µPa SPL root mean square[3]

dB: decibels, µPa: micropascals, PTS: permanent threshold shift, SEL: sound exposure level, SPL: sound pressure level, TTS: temporary threshold shift
[1] M=Mass of animals (kg) as shown for each species, DRm=depth of animal (m)
[2] (T): Turtle weighting function
[3] The time interval for determining the root mean square that which contains 90% of the total energy within the envelope of the pulse. This windowing procedure for impulse signals removes uncertainty about where to set the exact temporal beginning or end of the signal, which may be obscured by ambient noise.

The ranges to the PTS threshold (i.e., range to the onset of PTS: the maximum distance to which PTS would be expected) are shown in Table 72 relative to the marine mammal's functional hearing group. For a SQS-53 sonar transmitting for 1 second at 3 kHz and a representative source level of 235 dB re 1 µPa^2-s at 1 m, the range to PTS for the most sensitive species (the high-frequency cetaceans) extends from the source to a range of 100 m (110 yd.). Since any hull mounted sonar, such as the SQS-53, engaged in anti-submarine warfare training would be moving at between 10–15 knots (5.1–7.7 m/second) and nominally pinging every 50 seconds, the vessel will have traveled a minimum distance of approximately 260 m (280 yd) during the time between those pings (10 knots is the speed used in the Navy Acoustic Effects Model). As a result, there is little overlap of PTS footprints from successive pings, indicating that in most cases, an animal predicted to receive PTS would do so from a single exposure (i.e., ping). For all other functional hearing groups (low-frequency cetaceans, mid-frequency cetaceans, and phocid seals and manatees) single-ping PTS zones are within 100 m of the sound source. A scenario could occur where an animal does not leave the vicinity of a ship or travels a course parallel to the ship within the PTS zone; however, as indicated in Table 72, the distances required make PTS exposure less likely. For a Navy vessel moving at a nominal 10 knots, it is unlikely a marine mammal could maintain the speed to parallel the ship and receive adequate energy over successive pings to suffer PTS. For all sources except hull-mounted sonar (e.g., SQS-53 and BQQ-10) ranges to PTS are well within 50 m (55 yd), even for multiple pings (up to five pings) and the most sensitive functional hearing group (high-frequency cetaceans).

Table 72. Approximate Ranges to Permanent Threshold Shift Criteria for Each Functional Hearing Group for a Single Ping from Three of the Most Powerful Sonar Systems within Representative Ocean Acoustic Environments (FEIS/OEIS)

Functional Hearing Group	Ranges to the Onset of PTS for One Ping (meters)[1]		
	Sonar Bin MF1 (e.g., SQS-53; ASW Hull Mounted Sonar)	Sonar Bin MF4 (e.g., AQS-22; ASW Dipping Sonar)	Sonar Bin MF5 (e.g., SSQ-62; ASW Sonobuoy)
Low-Frequency Cetaceans	70	10	≤ 2
Mid-Frequency Cetaceans	10	≤ 2	≤ 2
High-Frequency Cetaceans	100	20	10
Phocid Seals and Manatees	80	10	≤ 2

ASW: anti-submarine warfare; PTS: permanent threshold shift
[1] Approximate ranges are based on spherical spreading (Transmission Loss = 20 log R, where R = range in meters).

Table 73 illustrates the ranges to the onset of TTS (i.e., the maximum distances to which TTS would be expected) for one, five, and ten pings from four representative sonar systems. Due to the lower acoustic thresholds for TTS versus PTS, ranges to TTS are longer. Therefore, it is possible for animals to remain in these areas over several successive pings and potentially suffer TTS.

Table 73. Approximate Ranges to the Onset of Temporary Threshold Shift for Four Representative Sonar Systems Over a Representative Range of Ocean Environments (FEIS/OEIS)

Functional Hearing Group	Approximate Ranges to the Onset of TTS (meters)[1]											
	Sonar Bin MF1 (e.g., SQS-53; ASW Hull Mounted Sonar)			Sonar Bin MF4 (e.g., AQS-22; ASW Dipping Sonar)			Sonar Bin MF5 (e.g., SSQ-62; ASW Sonobuoy)			Sonar Bin HF4 (e.g., SQQ-32; MIW Sonar)		
	One Ping	Five Pings	Ten Pings	One Ping	Five Pings	Ten Pings	One Ping	Five Pings	Ten Pings	One Ping	Five Pings	Ten Pings
Low-Frequency Cetaceans	560–2,280	1,230–6,250	1,620–8,860	220–240	490–1,910	750–2,700	110–120	240–310	340–1,560	100–160	150–730	150–820
Mid-Frequency Cetaceans	150–180	340–440	510–1,750	< 50	< 50	< 50	< 50	< 50	< 50	< 50	< 50	< 50
High-Frequency	2,170–7,570	4,050–15,350	5,430–19,500	90	180–190	260–950	< 50	< 50	< 50	< 50	< 50	< 50

Cetaceans												
Phocid Seals and Manatees	72–1,720	200–3,570	350–4,850	< 50	100	150	< 50	< 50	< 50	< 50	< 50	< 50

ASW: anti-submarine warfare; MIW: mine warfare; TTS: temporary threshold shift

[1] Ranges to TTS represent the model predictions in different areas and seasons within the Study Area. The zone in which animals are expected to receive TTS extends from onset-PTS to the distance indicated.

6.7.2.4 *Avoidance Behavior and Mitigation Measures as Applied to Sonar and Active Acoustic Sources*

The quantitative acoustic impacts presented in the *Draft EIS/OEIS for Atlantic Fleet Training and Testing* were the model-predicted impacts with consideration of during-activity avoidance behavior for exposures to sonar and other active acoustic sources. Additionally, the levels of certain activities were adjusted in the *Final EIS/OEIS for Atlantic Fleet Training and Testing* to reflect more accurate estimates of future training and testing needs and to correct errors. These changes are specifically identified in the Foreword of the *Final EIS/OEIS for Atlantic Fleet Training and Testing*. The general types and locations of training and testing did not change.

As described in the modeling technical report, the model accounts for an animat's position vertically in the water column by taking into account species-specific dive profiles; however, it does not account for an animat's horizontal movement, so the model assumes that an animal would remain stationary and tolerate repeated intense sound exposures at very close distances. This assumption is invalid because animals are likely to leave the area to avoid intense sound exposure that could cause injury. Similarly, the modeling assumes that certain species known to avoid areas of high anthropogenic activity would remain in the very close vicinity of all Navy training and testing activities, regardless of how many vessels or low-flying aircraft (i.e., helicopters) are involved. The outputs of the model, therefore, present an unrealistically high estimate of acoustic impacts in close proximity to certain Navy training and testing activities.

Additionally, the modeling currently does not account for implementation of mitigation designed to avoid or reduce marine mammal and sea turtle exposures to explosives and high intensity sound, nor does it account for standard operating procedures (procedures designed for the safety of personnel and equipment) implemented to ensure safety and mission success, but which may have incidental environmental benefits. That is, the modeling assumes that any mitigations measures, such as sonar power-down or delay of a detonation, would not be implemented even if an animal could be sighted within the mitigation zone. The Navy's proposed mitigations were developed in cooperation with the National Marine Fisheries Service (NMFS) and are designed to reduce environmental impacts while being operationally feasible. It is difficult to assess the effectiveness of mitigation measures; however, NMFS assesses annual exercise reports and comprehensive summary reports to assess trends in implementation and observed responses to mitigation. The outputs of the model (without mitigation), therefore, present an unrealistically high estimate of acoustic impacts within the mitigation zones of certain Navy training and testing activities.

In order to provide a holistic quantitative assessment of acoustic impacts, the post-model analysis quantitatively assessed the effect of animal avoidance behavior and implementation of mitigation, considering the following:

- Best available science on species' behavior
- Number of platforms (i.e., aircraft, vessels) used during specific activities
- Ability to detect specific species
- Ability to observe the mitigation zone around different platforms during different activities

The steps of the post-model analysis are briefly summarized in Table 74 and presented in the order they are expected to occur during an actual training or testing activity, which is also the order in which they were mathematically considered in the post-model analysis. When feasible for a given activity, mitigation begins prior to the actual production of underwater sound (e.g., 10-30 minutes, dependent upon platform, prior to most sonar and explosive activities); therefore, mitigation effectiveness is applied in the post-model analysis before animal avoidance is quantified.

Table 74. Post Model Acoustic Impact Analysis Process

Is the Sound Source Sonar/Other Active Acoustic Source or Explosives?	
Sonar and Other Active Acoustic Sources	**Explosives**
S-1. Is the activity preceded by multiple vessel activity or hovering helicopter?	**E-1. Is the activity preceded by multiple vessel activity or hovering helicopter?**
Species sensitive to human activity (i.e., harbor porpoises and beaked whales) are assumed to avoid the activity area, putting them out of the range to Level A harassment. Model-estimated PTS to these species during these activities are unlikely to actually occur and, therefore, are considered to be TTS (animal is assumed to move into the range of potential TTS). The activities preceded by multiple vessel movements or hovering helicopters are listed in Table 3.4-11 in 3.4.3.2 (Avoidance Behavior and Mitigation Measures as Applied to Sonar and Other Active Acoustic Sources) in the FEIS.	Species sensitive to human activity (i.e., harbor porpoises and beaked whales) are assumed to avoid the activity area, putting them out of the range to mortality. Model-estimated mortalities to these species during these activities are unlikely to actually occur and, therefore, are considered to be injuries (animal is assumed to move into the range of potential injury). The activities preceded by multiple vessel movements or hovering helicopters are listed in Table 3.4-23 in Section **Error! Reference source not found.** Avoidance Behavior and Mitigation as Applied to Explosives) in the FEIS.
S-3. Can Lookouts observe the activity-specific mitigation zone (see Chapter 5) up to and during the sound-producing activity?	**E-2. Can Lookouts observe the activity-specific mitigation zone (see Chapter 5) up to and during the sound-producing activity?**
If Lookouts are able to observe the mitigation zone up to and during a sound-producing activity, the sound-producing activity would be halted or delayed if a marine mammal is observed and would not resume until the animal is thought to be out of the mitigation zone (per the mitigation measures in Chapter 5). Therefore, model-	If Lookouts are able to observe the mitigation zone up to and during an explosion, the explosive activity would be halted or delayed if a marine mammal is observed and would not resume until the animal is thought to be out of the mitigation zone (per the mitigation measures in Chapter 5). Therefore, model-estimated mortalities and

estimated PTS exposures are reduced by the portion of animals that are likely to be seen [Mitigation Effectiveness (1, 0.5, or 0) x Sightability, g(0)]. Any animals removed from the model-estimated PTS are instead assumed to be TTS (animal is assumed to move into the range of TTS). The g(0) value is associated with the platform (vessel or aircraft) with the dedicated Lookout(s). For activities with lookouts on both platforms, the higher g(0) is used for analysis. The g(0) values are provided in Table 5.3-1. The Mitigation Effectiveness values are provided in Table 3.4-12 in Section 3.4.3.1.8.2 (Avoidance Behavior and Mitigation Measures as Applied to Sonar and Other Active Acoustic Sources) in the FEIS.	injuries are reduced by the portion of animals that are likely to be seen [Mitigation Effectiveness (1, 0.5, or 0) x Sightability, g(0)]. Any animals removed from the model-estimated mortalities or injuries are instead assumed to be injuries or behavioral disturbances, respectively (animals are assumed to move into the range of a lower effect). The g(0) value is associated with the platform (vessel or aircraft) with the dedicated Lookout(s). For activities with lookouts on both platforms, the higher g(0) is used for analysis. The g(0) values are provided in Table 5.3-1. The Mitigation Effectiveness values for explosive activities are provided in Table 3.4-24 in Section **Error! eference source not found.** (Avoidance Behavior and Mitigation as Applied to Explosives) in the FEIS.

6.7.2.5 *Mitigation*

The Navy Acoustic Effects Model estimates acoustic effects without taking into account any shutdown or delay of the activity when marine mammals are present and detectable within the mitigation zone; therefore, the model overestimates impacts to marine mammals within mitigation zones. The post-model analysis considers and quantifies the potential for mitigation to reduce the likelihood or risk of PTS (due to sonar and other active acoustic sources) and injuries and mortalities (due to explosives).

Two factors are considered when quantifying the effectiveness of mitigation: (1) the extent to which the type of mitigation proposed for a sound-producing activity (e.g., active sonar) allows for observation of the mitigation zone prior to and during the activity and (2) the sightability of each species that may be present in the mitigation zone, which is affected by species-specific characteristics.

6.7.2.6 *Avoidance*

At close ranges and high sound levels approaching those that could cause PTS, avoidance of the area immediately around the sound source is the assumed behavioral response for most cases. Because the Navy Acoustic Effects Model does not consider horizontal movement of animats, including avoidance of high-intensity sound exposures, it over-estimates the number of marine mammals and sea turtles that would be exposed to sound sources that could cause injury. In other words, the model estimates PTS impacts as though an animal would tolerate an injurious sound exposure without moving away from the sound source. Therefore, the potential for avoidance is considered in the Navy's post-model analysis.

6.7.3 **Overview of Risk from Acoustic Stressors**

The addition of sound to the marine environment is recognized by the scientific community (Payne 1971), as a threat that could possibly harm marine mammals or significantly interfere with their normal activities (NRC 2005a). Assessing whether a sound may disturb or injure a marine mammal involves understanding the characteristics of the acoustic sources, the marine mammals that may be present in the vicinity of the sound, and the effects that sound may have on the physiology and behavior of those marine mammals. Although it is known that sound is important for marine mammal communication, navigation, and foraging (NRC 2005a), there are many unknowns in assessing impacts such as the potential interaction of different effects and the significance of responses by marine mammals to sound exposures (Nowacek et al. 2007; Southall et al. 2007a).

6.7.3.1 *Potential Injury Resulting from Sound*

For the purposes of this assessment, an injury is physical trauma or damage that is a direct result of an acoustic exposure, regardless of the potential consequences of that injury to an animal (we distinguish between injuries that result from an acoustic exposure and injuries that result from an animal's behavioral reaction to an acoustic exposure, which are discussed later in this section of the Opinion). Based on the literature available, active sonar might injure marine animals through two mechanisms: acoustic resonance and noise-induced loss of hearing sensitivity (more commonly-called threshold shift). Potential direct injury from non-impulsive sound sources, such as sonar, is unlikely due to relatively lower peak pressures and slower rise times than potentially injurious sources such as explosives. Even for the most sensitive auditory tissues, including strandings associated with use of sonar, Ketten (2012)has recently summarized, "to date, there has been no demonstrable evidence of acute, traumatic, disruptive, or profound auditory damage in any marine mammal as the result [of] anthropogenic noise exposures, including sonar."

Relatively little is known about auditory system trauma in marine mammals resulting from a 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 kilogram (kg) (11,023 lb) explosive (Ketten et al. 1993a). The exact magnitude of the exposure in that study was not determined, but it is likely the trauma was caused by the shock wave produced by the explosion. There are no known occurrences of direct auditory trauma in marine mammals exposed to tactical sonar or other non-impulsive sound sources (Ketten 2012). The potential for auditory trauma in marine mammals exposed to impulsive sources (e.g., explosions) is inferred from tests of submerged terrestrial mammals exposed to underwater explosions (Ketten et al. 1993a; Richmond et al. 1973a; Yelverton et al. 1973a).

Direct, non-auditory tissue damage may occur after exposure to high amplitude impulsive sources, such as explosions. Primary blast injury is usually limited to gas- containing structures (e.g., lung and gut) and the auditory system (Ketten et al. 2001; Stuhmiller et al. 1990){Craig Jr., 1998 #155862}. Barotrauma refers to injuries caused when large pressure changes occur across tissue interfaces, normally at the boundaries of air-filled tissues such as the lungs. Primary blast injury to the respiratory system, as measured in terrestrial mammals, may consist of pulmonary contusions, pneumothorax, pneumomediastinum, traumatic lung cysts, or interstitial or subcutaneous emphysema (Stuhmiller et al. 1990). These injuries may be fatal depending upon the severity of the trauma. Rupture of the lung may introduce air into the vascular system, possibly producing air emboli that can cause a cerebral infarct or heart attack by restricting oxygen delivery to these organs. Though often secondary in life-threatening severity to pulmonary blast trauma, the gastrointestinal tract can also suffer contusions and lacerations from blast exposure, particularly in air-containing regions of the tract. Potential traumas include hematoma, bowel perforation, mesenteric tears, and ruptures of the hollow abdominal viscera.

Although hemorrhage of solid organs (e.g., liver, spleen, and kidney) from blast exposure is possible, rupture of these organs is rarely encountered.

A known occurrence of mortality to a marine mammal due to a U.S. Navy training or testing event involved the use of underwater explosives in March 2011 in nearshore waters off San Diego, California, at the Silver Strand Training Complex. This area has been used for underwater demolitions training for at least three decades without incident. On this occasion, however, a group of long-beaked common dolphins entered the mitigation zone and approximately 1 minute after detonation, three animals were observed dead at the surface; a fourth animal was discovered three days later stranded dead approximately 42 mi. (68 km) to the north of the detonation site. Upon necropsy, all four animals were found to have sustained typical mammalian primary blast injuries (Danil and Leger 2011).

6.7.3.2 ***Acoustic Resonance***

Acoustic resonance results from hydraulic damage in tissues that are filled with gas or air that resonates when exposed to acoustic signals (Rommel et al. 2007). Based on studies of lesions in beaked whales that stranded in the Canary Islands and Bahamas associated with exposure to naval exercises that involved sonar, investigators have identified two physiological mechanisms that might explain some of those stranding events: tissue damage resulting from resonance effects (Cudahy and Ellison 2002; Ketten et al. 2004) and tissue damage resulting from gas and fat embolic syndrome (Fernández et al. 2005; Jepson et al. 2003). Fat and gas embolisms are believed to occur when tissues are supersaturated with dissolved nitrogen gas and diffusion facilitated by bubble-growth is stimulated within those tissues (the bubble growth results in embolisms analogous to the bends in human divers).

Cudahy and Ellison (2002) analyzed the potential for resonance from low frequency sonar signals to cause injury and concluded that the expected threshold for in vivo (in the living body) tissue damage for underwater sound is on the order of 180 to 190 dB. There is limited direct empirical evidence (beyond Schlundt et al. 2000b) to support a conclusion that 180 dB is “safe” for marine mammals; however, evidence from marine mammal vocalizations suggests that 180 dB is not likely to physically injure marine mammals. For example, Frankel (1994) estimated the source level for singing humpback whales to be between 170 and 175 dB; McDonald et al. (2001a) calculated the average source level for blue whale calls as 186 dB, Watkins et al. (1987a) found source levels for fin whales up to 186 dB, and Møhl et al. (2000) recorded source levels for sperm whale clicks up to 223 dB. Because whales are not likely to communicate at source levels that would damage the tissues of other members of their species, this evidence suggests that these source levels are not likely to damage the tissues of the endangered and threatened species being considered in this consultation.

Crum and Mao (1994) hypothesized that received levels would have to exceed 190 dB in order for there to be the possibility of significant bubble growth due to super-saturation of gases in the blood. Jepson et al. (2003; 2005) and Fernández et al. (2004; 2005) concluded that in vivo bubble formation, which may be exacerbated by deep, long- duration, repetitive dives may explain why beaked whales appear to be particularly vulnerable to sonar exposures.

A recent paper by Kvadsheim et al. (2012) explored the risk of decompression sickness in several cetacean species. Their model estimates suggest that shallow (killer whales), intermediate (pilot whales) and deep diving whales (sperm whales, Cuvier's beaked whale, and Blainville's beaked whale) all live with high blood and tissue partial pressure nitrogen (PN2) levels, but the deep divers seem to experience the most extreme values. The deep diving sperm whales which respond to sonar exposure by shallower but still deep diving were found to increase risk of decompression sickness, but not beyond the normal risk range of sperm whales. Further, they found no systematic changes during sonar exposure in the other species, for some animals partial pressure nitrogen level appeared to increase slightly, while for others it decreased. However, the variation increased with dive depth. Their results suggest that all species have natural high nitrogen levels, with deep diving generally resulting in higher end-dive partial pressure nitrogen as compared with shallow diving.

Sonar exposure caused some changes in dive behavior in both killer whales, pilot whales and beaked whales, but it did not lead to any increased risk of decompression sickness. However, in three of eight exposure sessions with sperm whales, the animal changed to shallower diving, and in all these cases this seemed to result in an increased risk of decompression sickness, although risk was still within the normal risk range of this species. When a hypothetical removal of the normal dive response (bradycardia and peripheral vasoconstriction), was added to the behavioral response during model simulations, this led to an increased variance in the estimated end-dive N2 levels, but no consistent change of risk. Kvadsheim et al. (2012) could not rule out the possibility that a combination of behavioral and physiological responses to sonar have the potential to alter the blood and tissue end-dive N2 tension to levels which could cause decompression sickness and formation of in vivo bubbles, but their actually observed behavioral responses of cetaceans to sonar in their study, did not imply any significantly increased risk of decompression sickness.

6.7.3.3 ***Noise-Induced Loss of Hearing Sensitivity***

Noise-induced loss of hearing sensitivity or threshold shift refers to an ear's reduced sensitivity to sound following exposure to loud noises; when an ear's sensitivity to sound has been reduced, sounds must be louder for an animal to detect and recognize it. Noise-induced loss of hearing sensitivity is usually represented by the increase in intensity (in decibels) sounds must have to be detected. These losses in hearing sensitivity rarely affect the entire frequency range an ear might be capable of detecting, instead, they affect the frequency ranges that are roughly equivalent to or slightly higher than the frequency range of the noise itself. Nevertheless, most investigators who study TTS in marine mammals report the frequency range of the noise, which would change as the spectral qualities of a waveform change as it moves through water, rather than the frequency range of the animals they study. Without information on the frequencies of the sounds we consider in this Opinion at the point at which it is received by endangered and threatened marine mammals, we assume that the frequencies are roughly equivalent to the frequencies of the source.

Acoustic exposures can result in three main forms of noise-induced losses in hearing sensitivity: permanent threshold shift, temporary threshold shift, and compound threshold shift (Ward et al. 1998; Yost 2007). When permanent loss of hearing sensitivity, or PTS, occurs, there is physical damage to the sound receptors (hair cells) in the ear that can result in total or partial deafness, or an animal's hearing can be permanently impaired in specific frequency ranges, which can cause the animal to be less sensitive to sounds in that frequency range. Traditionally, investigations of temporary loss of hearing sensitivity, or TTS, have focused on sound receptors (hair cell damage) and have concluded that this form of threshold shift is temporary because hair cell damage does not accompany TTS and losses in hearing sensitivity are short-term and are followed by a period of recovery to pre-exposure hearing sensitivity that can last for minutes, days, or weeks. More recently, however, Kujawa and Liberman (2009) reported on noise-induced degeneration of the cochlear nerve that is a delayed result of acoustic exposures that produce TTS, that occurs in the absence of hair cell damage, and that is irreversible. They concluded that the reversibility of noise induced threshold shifts, or TTS, can disguise progressive neuropathology that would have long-term consequences on an animal's ability to process acoustic information. If this phenomenon occurs in a wide range of species, TTS may have more permanent effects on an animal's hearing sensitivity than earlier studies would lead us to recognize.

Although the published body of science literature contains numerous theoretical studies and discussion papers on hearing impairments that can occur with exposure to a strong sound, only a few studies provide empirical information on noise-induced loss in hearing sensitivity in marine mammals. Hearing loss due to auditory fatigue in marine mammals was studied by numerous investigators (Finneran et al. 2010a; Finneran et al. 2010b; Finneran et al. 2005; Finneran and Schlundt 2010; Finneran et al. 2007; Finneran et al. 2000b; Finneran et al. 2002b; Kastak et al. 2007; Lucke et al. 2009; Mann et al. 2010; Mooney et al. 2009a; Mooney et al. 2009b; Nachtigall et al. 2003; Nachtigall et al. 2004; Popov et al. 2011; Schlundt et al. 2000a; Southall et al. 2007b) The studies of marine mammal auditory fatigue were all designed to determine relationships between TTS and exposure parameters such as level, duration, and frequency. In these studies, hearing thresholds were measured in trained marine mammals before and after exposure to intense sounds. The difference between the pre-exposure and post-exposure thresholds indicates the amount of TTS. Species studied include the bottlenose dolphin (total of nine individuals), beluga (2), harbor porpoise (1), finless porpoise (2), California sea lion (3), harbor seal (1), and northern elephant seal (1). 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. 2000a).

Primary findings of the marine mammal TTS studies discussed above are:

- The growth and recovery of TTS are analogous to those in terrestrial mammals. This means that, as in terrestrial mammals, threshold shifts primarily depend on the amplitude, duration, frequency content, and temporal pattern of the sound exposure.
- The amount of TTS increases with exposure sound pressure level and the exposure duration.
- For continuous sounds, exposures of equal energy lead to approximately equal effects (Ward 1997). For intermittent sounds, less hearing loss occurs 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).

- The Sound Exposure Level is correlated with the amount of TTS and is a good predictor for onset-TTS from single, continuous exposures with similar durations. This agrees with human TTS data presented by Ward et al. (1958; 1959). However, for longer duration sounds, beyond 16–32 seconds, the relationship between TTS and sound exposure level breaks down, and duration becomes a more important contributor to TTS (Finneran et al. 2010a).
- The maximum TTS after tonal exposures occurs one-half to one octave above the exposure frequency (Finneran et al. 2007; Schlundt et al. 2000a). Thus, TTS from tonal exposures can extend over a large (greater than one octave) frequency range.
- For bottlenose dolphins, non-impulsive sounds with frequencies above 10 kHz are more hazardous than those at lower frequencies (i.e., lower sound exposure levels required to affect hearing) (Finneran and Schlundt 2010).
- The amount of observed TTS tends to decrease at differing rates following noise exposure; however, the relationship is not monotonic. The amount of time required for complete recovery of hearing depends on the magnitude of the initial shift; for relatively small shifts, recovery may be complete in a few minutes, while large shifts (e.g., 40 dB) require several days for recovery.
- TTS can accumulate across multiple intermittent exposures, but the resulting TTS will be less than the TTS from a single, continuous exposure with the same sound exposure level. This means that predictions based on total, cumulative sound exposure level will overestimate the amount of TTS from intermittent exposures.

Most of the few studies available have reported the responses of captive animals exposed to sounds in controlled experiments. Schlundt et al. (2000b), see also Finneran et al. (2003; 2001) provided a detailed summary of the behavioral responses of trained marine mammals during TTS tests conducted at the Navy's SPAWAR Systems Center with 1-second tones. Schlundt et al. (2000b), reported on eight individual TTS experiments that were conducted in San Diego Bay. Fatiguing stimuli durations were 1 second. 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.

Finneran et al. (2003; 2001) conducted TTS experiments using 1-second duration tones at 3 kHz. The test method was similar to that of Schlundt et al. (2000b) except the tests were conducted in a pool with a very low ambient noise level (below 50 dB re 1 μPa2/Hz), and no masking noise was used. The signal was a sinusoidal amplitude modulated tone with a carrier frequency of 12 kHz, modulating frequency of 7 Hz, and SPL of approximately 100 dB re 1 μPa. Two separate experiments were conducted. 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. Richardson et al.(1995e) hypothesized that marine mammals within less than 100 meters of a sonar source might be exposed to mid-frequency active sonar transmissions at received levels greater than 205 dB re 1 μPa which might cause TTS. However, there is no empirical evidence that exposure to active sonar transmissions with this kind of intensity can cause PTS in any marine mammals; instead the probability of PTS has been inferred from studies of TTS (see Richardson et al. 1995e). On the other hand, Kujawa and Liberman (2009) argued that traditional testing of threshold shifts, which have focused based on recovery of threshold sensitivities after exposure to noise, would miss acute loss of afferent nerve terminals and chronic degeneration of the cochlear nerve, which would have the effect of permanently reducing an animal's ability to perceive and process acoustic signals. Based on their studies of small mammals, Kujawa and Liberman (2009) reported that two hours of acoustic exposures produced moderate temporary threshold shifts but caused delayed losses of afferent nerve terminals and chronic degeneration of the cochlear nerve in test animals.

Despite the extensive amount of attention given to threshold shifts by researchers, environmental assessments conducted by the Navy and seismic survey operators, and its use in permits issued by NMFS Permits Division, it is not certain that threshold shifts are common. Several variables affect the amount of loss in hearing sensitivity: the level, duration, spectral content, and temporal pattern of exposure to an acoustic stimulus as well as differences in the sensitivity of individuals and species. All of these factors combine to determine whether an individual organism is likely to experience a loss in hearing sensitivity as a result of acoustic exposure (Ward et al. 1998; Yost 2007). In free-ranging marine mammals, an animal's behavioral responses to a single acoustic exposure or a series of acoustic exposure events would also determine whether the animal is likely to experience losses in hearing sensitivity as a result of acoustic exposure. Unlike humans whose occupations or living conditions expose them to sources of potentially-harmful noise, in most circumstances, free-ranging animals are not likely to remain in a sound field that contains potentially harmful levels of noise unless they have a compelling reason to do so (for example, if they must feed or reproduce in a specific location). Any behavioral responses that would take an animal out of a sound field or reduce the intensity of its exposure to the sound field would also reduce the animal's probability of experiencing noise-induced losses in hearing sensitivity.

More importantly, the data on captive animals and the limited information from free-ranging animals suggest that temporary noise-induced hearing losses do not have direct or indirect effect on the longevity or reproductive success of animals with this affliction. Like humans, free-ranging animals might experience short-term impairment in their ability to use their sense of hearing to detect environmental cues while their ears recover from the temporary loss of hearing sensitivity. Although we could not locate information regarding how animals that experience noise induced hearing loss alter their behavior or the consequences of any altered behavior on the lifetime reproductive success of those individuals, the limited information available would not lead us to expect temporary losses in hearing sensitivity to incrementally reduce the lifetime reproductive success of animals.

6.7.3.4 *Auditory Masking*

Marine mammals use acoustic signals for a variety of purposes, which differ among species, but include communication between individuals, navigation, foraging, reproduction, and learning about their environment (Erbe and Farmer 2000; Tyack and Clark 2000). Masking, or auditory interference, generally occurs when sounds in an animal's environment are louder than and of a similar frequency to, acoustic signals on which the animal is trying to focus.

Masking can occur (1) when competing sounds reduce or eliminate the salience of the acoustic signal or cue on which the animal is trying to focus or (2) when the spectral characteristics of competing sounds reduce or eliminate the coherence of acoustic signals on which the animal is trying to focus. In the former, the masking noise might prevent a focal signal from being salient to an animal; in the latter, the masking noise might prevent a focal signal from being coherent to an animal. Masking, therefore, is a phenomenon that affects animals that are trying to receive acoustic information about their environment, including sounds from other members of their species, predators, prey, and sounds that allow them to orient in their environment. Masking these acoustic signals can disturb the behavior of individual animals, groups of animals, or entire populations.

Richardson et al. (1995e) argued that the maximum radius of influence of an industrial noise (including broadband low frequency sound transmission) on a marine mammal is the distance from the source to the point at which the noise can barely be heard. This range is determined by either the hearing sensitivity of the animal or the background noise level present. Industrial masking is most likely to affect some species' ability to detect communication calls and natural sounds (i.e., vocalizations from other members of its species, surf noise, prey noise, etc.; Richardson et al. 1995e).

Sperm whales have been observed to frequently stop echolocating in the presence of underwater pulses produced by echosounders and submarine sonar (Watkins 1985; Watkins and Schevill 1975a). They also stop vocalizing for brief periods when codas are being produced by other individuals, perhaps because they can hear better when not vocalizing themselves (Goold and Jones 1995).

Because they spend large amounts of time at depth and use low frequency sound sperm whales are likely to be susceptible to low frequency sound in the ocean (Croll et al. 1999b). Furthermore, because of their apparent role as important predators of mesopelagic squid and fish, changes in their abundance could affect the distribution and abundance of other marine species.

The echolocation calls of toothed whales are subject to masking by high frequency sound. Human data indicate low frequency sound can mask high frequency sounds (i.e., upward masking). Studies on captive odontocetes by Au et al. (Au 1993; Au et al. 1985; Au et al. 1974) indicate that some species may use various processes to reduce masking effects (e.g., adjustments in echolocation call intensity or frequency as a function of background noise conditions). There is also evidence that the directional hearing abilities of odontocetes are useful in reducing masking at the high frequencies these cetaceans use to echolocate, but not at the low-to-moderate frequencies they use for communication (Zaitseva et al. 1980).

As with hearing loss, auditory masking can effectively limit the distance over which a marine mammal can communicate, detect biologically relevant sounds, and echolocate (odontocetes). Unlike auditory fatigue, which always results in a localized stress response, behavioral changes resulting from auditory masking may not be coupled with a stress response. Another important distinction between masking and hearing loss is that masking only occurs in the presence of the sound stimulus, whereas hearing loss can persist after the stimulus is gone.

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 (Au and Pawloski 1989; Erbe

2000){Johnson, 1971 #155865}. These studies provide baseline information from which the probability of masking can be estimated.

Clark et al. (2009b) developed a methodology for estimating masking effects on communication signals for low frequency cetaceans, including calculating the cumulative impact of multiple noise sources. For example, their technique calculates that in Stellwagen Bank National Marine Sanctuary, when two commercial vessels pass through a North Atlantic right whale's optimal communication space (estimated as a sphere of water with a diameter of 20 km), that space is decreased by 84 percent. This methodology relies on empirical data on source levels of calls (which is unknown for many species), and requires many assumptions about ancient ambient noise conditions and simplifications of animal behavior, but it is an important step in determining the impact of anthropogenic noise on animal communication.

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 to vocal behavior and call structure may result from a need to compensate for an increase in background noise. In cetaceans, vocalization changes have been reported from exposure to anthropogenic noise sources such as sonar, vessel noise, and seismic surveying.

In the presence of low frequency active sonar, humpback whales have been observed to increase the length of their 'songs' (Fristrup and Clark 2003; Miller et al. 2000), possibly due to the overlap in frequencies between the whale song and the low frequency active sonar. North Atlantic 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. 2007a) as well as increasing the amplitude (intensity) of their calls (Parks 2009). In contrast, both sperm and pilot whales potentially ceased sound production during the Heard Island feasibility test (Bowles et al. 1994a), 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.

Differential vocal responding in marine mammals has been documented in the presence of seismic survey noise. An overall decrease in vocalization during active surveying has been noted in large marine mammal groups (Potter et al. 2007), while blue whale feeding/social calls increased when seismic exploration was underway (Di Lorio and Clark. 2010), indicative of a potentially compensatory response to the increased noise level. Melcon et al. (2012) recently documented that blue whales decreased the proportion of time spent producing certain types of calls when mid-frequency sonar was present. At present it is not known if these changes in vocal behavior corresponded to changes in foraging or any other behaviors.

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.

6.7.3.5 ***Behavioral Responses***

Marine animals have not had the time and have not experienced the selective pressure necessary for them to have evolved a behavioral repertoire containing a set of potential responses to active sonar, other potential stressors associated with naval military readiness activities, or human disturbance generally. Instead, marine animals invoke behavioral responses that are already in their behavioral repertoire to decide how they will behaviorally respond to active sonar, other potential stressors associated with naval military readiness activities, or human disturbance generally. An extensive number of studies have established that these animals will invoke the same behavioral responses they would invoke when faced with predation and will make the same ecological considerations when they experience human disturbance that they make when they perceive they have some risk of predation (Beale and Monaghan 2004b; Frid 2003; Frid and Dill 2002; Gill and Sutherland 2001; Harrington and Veitch 1992; Lima 1998; Romero 2004). Specifically, when animals are faced with a predator or predatory stimulus, they consider the risks of predation, the costs of anti-predator behavior, and the benefits of continuing a pre-existing behavioral pattern when deciding which behavioral response is appropriate in a given circumstance (Bejder et al. 2009; Gill and Sutherland 2001; Houston et al. 1993; Lima 1998; Lima and Bednekoff 1999; Ydenberg and Dills 1986). Further, animals appear to detect and adjust their responses to temporal variation in predation risks (Lima and Bednekoff 1999; Rodriguez-Prieto et al. 2009).

Several researchers have published papers based on studies conducted in the Tongue of the Ocean (Bahamas) on the Autec Range (Claridge and Dunn 2011; Mccarthy et al. 2011; Moretti et al. 2010; Pirotta et al. 2012a; Tyack et al. 2011a). The military array of bottom-mounted hydrophones was used to measure the response based upon changes in the spatial and temporal pattern of vocalizations of Blainville's beaked whales (*Mesoplodon densirostris*).

Pirotta et al. (Pirotta et al. 2012a) conducted an experiment involving the exposure of target whale groups to intense vessel-generated noise tested how these exposures influenced the foraging behavior of Blainville's beaked whales. They found that the duration of foraging bouts was not significantly affected by exposure to vessel noise. Changes were found in the hydrophone over which the group was most frequently detected as the animals moved around within a foraging bout, and their number was significantly less the closer the whales were to the sound source. Non-exposed groups had significantly more changes in the primary hydrophone than exposed groups irrespective of distance. Their results suggested that broadband ship noise caused a significant change in beaked whale behavior up to at least 5.2 kilometers away from the vessel. They concluded that observed change could potentially correspond to a restriction in the movement of groups, a period of more directional travel, a reduction in the number of individuals clicking within the group, or a response to changes in prey movement.

The response of a marine mammal to an anthropogenic sound will depend on the frequency, 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 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). For marine mammals, a review of responses to anthropogenic sound was first conducted by Richardson and others (Richardson et al. 1995e). More recent reviews (Nowacek 2007; Southall et al. 2007a) address studies conducted since 1995 and focus on observations where the received sound level of the exposed marine mammal(s) was known or could be estimated.

Except for some vocalization changes that may be compensating for auditory masking, all behavioral reactions are assumed to occur due to a preceding stress or cueing response; however, stress responses cannot be predicted directly due to a lack of scientific data (see preceding section). Responses can 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.

Southall et al. (2007a) synthesized data from many past behavioral studies and observations to determine the likelihood of behavioral reactions at specific sound levels. While in general, the louder the sound source the more intense the behavioral response, it was clear that the proximity of a sound source and the animal's experience, motivation, and conditioning were also critical factors influencing the response (Southall et al. 2007a). After examining all of the available data, the authors felt that the derivation of thresholds for behavioral response based solely on exposure level was not supported because context of the animal at the time of sound exposure was an important factor in estimating response. Nonetheless, in some conditions consistent avoidance reactions were noted at higher sound levels dependent on the marine mammal species or group allowing conclusions to be drawn. Most low-frequency cetaceans (mysticetes) observed in studies usually avoided sound sources at levels of less than or equal to 160 dB re 1 µPa. Published studies of mid-frequency cetaceans analyzed include sperm whales, belugas, bottlenose dolphins, and river dolphins. These groups showed no clear tendency, but for non-impulsive sounds, captive animals tolerated levels in excess of 170 dB re 1 µPa before showing behavioral reactions, such as avoidance, erratic swimming, and attacking the test apparatus. High-frequency cetaceans (observed from studies with harbor porpoises) exhibited changes in respiration and avoidance behavior at levels between 90 and 140 dB re 1 µPa, with profound avoidance behavior noted for levels exceeding this. Phocid seals showed avoidance reactions at or below 190 dB re 1 µPa, thus seals may actually receive levels adequate to produce TTS before avoiding the source. Recent studies with beaked whales have shown them to be particularly sensitive to noise, with animals during 3 playbacks of sound breaking off foraging dives at levels below 142 dB re 1 µPa, although acoustic monitoring during actual sonar exercises revealed some beaked whales continuing to forage at levels up to 157 dB re 1 µPa (Tyack et al. 2011b).

The level of risk an animal perceives results from a combination of factors that include the perceived distance between an animal and a potential predator, whether the potential predator is approaching the animal or moving tangential to the animal, the number of times the potential predator changes its vector (or evidence that the potential predator might begin an approach), the speed of any approach, the availability of refugia, and the health or somatic condition of the animal, for example, along with factors related to natural predation risk (Frid and Dill 2002; Papouchis et al. 2001). In response to a perceived threat, animals can experience physiological changes that prepare them for flight or fight responses or they can experience physiological changes with chronic exposure to stressors that have more serious consequences such as interruptions of essential behavioral or physiological events, alteration of an animal's time budget, or some combination of these responses (Frid and Dill 2002; Romero 2004; Sapolsky 2000; Walker et al. 2005).

The behavioral responses of animals to human disturbance have been documented to cause animals to abandon nesting and foraging sites (Sutherland and Crockford 1993), cause animals to increase their activity levels and suffer premature deaths or reduced reproductive success when their energy expenditures exceed their energy budgets (Daan et al. 1996; Feare 1976; Giese 1996; Müllner et al. 2004), or cause animals to experience higher predation rates when they adopt risk-prone foraging or migratory strategies (Frid and Dill 2002).

Based on the evidence available from empirical studies of animal responses to human disturbance, marine animals are likely to exhibit one of several behavioral responses upon being exposed to sonar transmissions: (1) they may engage in horizontal or vertical avoidance behavior to avoid exposure or continued exposure to a sound that is painful, noxious, or that they perceive as threatening; (2) they may engage in evasive behavior to escape exposure or continued exposure to a sound that is painful, noxious, or that they perceive as threatening, which we would assume would be accompanied by acute stress physiology; (3) they may remain continuously vigilant of the source of the acoustic stimulus, which would alter their time budget. That is, during the time they are vigilant, they are not engaged in other behavior; and (4) they may continue their pre-disturbance behavior and cope with the physiological consequences of continued exposure.

Marine animals might experience one of these behavioral responses, they might experience a sequence of several of these behaviors (for example, an animal might continue its pre-disturbance behavior for a period of time, then abandon an area after it experiences the consequences of physiological stress) or one of these behaviors might accompany responses such as permanent or temporary loss in hearing sensitivity. The narratives that follow summarize the information available on these behavioral responses.

6.7.3.6 *Behavioral Avoidance of Initial Exposures or Continued Exposure*

As used in this Opinion, behavioral avoidance refers to animals that abandon an area in which active sonar is being used to avoid being exposed to the sonar (regardless of how long it takes them to return to the area after they have abandoned it), animals that avoid being exposed to the entire sound field produced by active sonar; and animals that avoid being exposed to particular received levels within a sound field produced by active sonar. Richardson et al. (1979) noted that avoidance reactions are the most obvious manifestations of disturbance in marine mammals. There are few empirical studies of avoidance responses of free-living cetaceans to mid-frequency sonar.

However, Kvadsheim et al. (2007) conducted a controlled exposure experiment in which killer whales (Orcinus orca) that had been fitted with D-tags were exposed to mid-frequency active sonar (Source A: was a 1.0 s upsweep 209 dB @ 1 - 2 kHz every 10 seconds for 10 minutes; Source B: was a 1.0 s upsweep 197 dB @ 6 - 7 kHz every 10 s for 10 min). When exposed to Source A, a tagged killer whale and the group it was traveling with did not appear to avoid the source. When exposed to Source B, the tagged whales along with other whales that had been carousel feeding, ceased feeding during the approach of the sonar and moved rapidly away from the source (the received level associated with this response was not reported). When exposed to Source B, Kvadsheim and his co-workers reported that a tagged killer whale seemed to try to avoid further exposure to the sound field by immediately swimming away (horizontally) from the source of the sound; by engaging in a series of erratic and frequently deep dives that seemed to take it below the sound field; or by swimming away while engaged in a series of erratic and frequently deep dives. Although the sample sizes in this study are too small to support statistical analysis, the behavioral responses of the orcas were consistent with the results of other studies. Maybaum (Maybaum 1993) conducted sound playback experiments to assess the effects of mid-frequency active sonar on humpback whales in Hawaiian waters. Specifically, she exposed focal pods to sounds of a 3.3-kHz sonar pulse, a sonar frequency sweep from 3.1 to 3.6 kHz, and a control (blank) tape while monitoring the behavior, movement, and underwater vocalizations. The two types of sonar signals differed in their effects on the humpback whales, although the whales exhibited avoidance behavior when exposed to both sounds. The whales responded to the pulse by increasing their distance from the sound source and responded to the frequency sweep by increasing their swimming speeds and track linearity.

Tyack et al. (Tyack et al. 2011a) studied beaked whales in a naval underwater range where sonars were in regular use near Andros Island, Bahamas. An array of bottom-mounted hydrophones detected beaked whales when they click anywhere within the range area. They used two complementary methods to investigate behavioral responses of beaked whales to sonar: an opportunistic approach that monitored whale responses to multi-day naval exercises involving tactical mid-frequency sonars, and an experimental approach using playbacks of simulated sonar and control sounds to whales tagged with a device that records sound, movement, and orientation. They found that in both exposure conditions beaked whales stopped echolocating during deep foraging dives and moved away. During actual sonar exercises, beaked whales were primarily detected near the periphery of the range, on average 16 km away from the sonar transmissions. Once the exercise stopped, beaked whales gradually filled in the center of the range over 2–3 days. A satellite tagged whale moved outside the range during an exercise, returning over 2–3 days post-exercise (Tyack et al. 2011a). Their experimental approach used tags to measure acoustic exposure and behavioral reactions of beaked whales to one controlled exposure each of simulated military sonar, killer whale calls, and band-limited noise. The beaked whales reacted to these three sound playbacks at sound pressure levels below 142 dB re 1µPa by stopping echolocation followed by unusually long and slow ascents from their foraging dives.

McCarthy et al (2011) investigated changes in spatial and temporal distribution of vocal behavior of Blainville's beaked whales during multiship exercises with mid-frequency sonar. They found a decline in vocalization activity associated with foraging groups of Blainville's beaked whales during military exercises and postulated three possible explanations: (1) the animals moved off the range but continued to vocalize, (2) the animals did not vocalize during the military operations, or (3) the system failed to detect whale vocalizations in the midst of noise associated with military operations (i.e., masking occurred). The results of their analysis strongly suggest that the animals avoided ships using active sonar and moved off range during such exercises. Further, the data suggest animals return to the range after the cessation of sonar activity.

As stated above, Tyack et al. (2011a) investigated the behavioral responses of beaked whales to multi-day naval exercises involving mid-frequency active sonar, playbacks of simulated sonar, and recorded killer whale calls with a device that records sound, movement, and orientation at the Atlantic Undersea Test and Evaluation Center (AUTEC), in the Tongue of the Ocean near Andros Island in the Bahamas. Tyack et al. (Tyack et al. 2011a) found that beaked whales stopped echolocating during deep foraging dives and moved away from both simulated active sonar and killer whale sounds. During actual sonar exercises, beaked whales were primarily detected near the periphery of the range, on average 16 km away from the sonar transmissions. Once the exercise stopped, beaked whales gradually filled in the center of the range over 2–3 days. A satellite tagged whale moved outside the range during an exercise, returning over 2–3 days post-exercise. The beaked whales reacted to these three sound playbacks at sound pressure levels below 142 dB re 1 µPa by stopping echolocation followed by unusually long and slow ascents from their foraging dives.

Tyack et al. (Tyack et al. 2011a) stated that there was no evidence that beaked whales at AUTEC have stranded during periods when naval mid-frequency active sonar is being used, only that beaked whales move out of the area where sonar was being operated. Further, they noted that the avoidance responses reduce exposure to sonar which was a similar response to playback of killer whale sounds. In both, the active sonar and the killer whale sound scenarios, the beaked whales exhibited a similar prolonged avoidance response. The tagged whales responded to the sonar exercise and to the killer whale playback not with panicked flight, but with well oriented swimming toward the only deep water exit from the Tongue of the Ocean (Tyack et al. 2011a).

Pirotta et al. (2012a) used the AUTEC facility to investigate how vessel noise affects beaked whale behavior. They conducted an experiment involving the exposure of target whale groups to intense vessel-generated noise to test how these exposures influenced the foraging behavior of Blainville's beaked whales in the Tongue of the Ocean (Bahamas). They found that the duration of foraging bouts was not significantly affected by exposure to vessel noise. Although changes in the hydrophone over which the group was most frequently detected occurred as the animals moved around within a foraging bout, and their number was significantly less the closer the whales were to the sound source. Non-exposed groups also had significantly more changes in the primary hydrophone than exposed groups irrespective of distance. They suggest that broadband ship noise caused a significant change in beaked whale behavior up to at least 5.2 kilometers away from the vessel.

In the Caribbean, sperm whales avoided exposure to mid-frequency submarine sonar pulses, in the range 1000 Hz to 10,000 Hz (IWC 2005a). Blue and fin whales have occasionally been reported in areas ensonified by airgun pulses; however, there have been no systematic analyses of their behavioral reactions to airguns. Sightings by observers on seismic vessels off the United Kingdom suggest that, at times of good sight-ability, the number of blue, fin, sei, and humpback whales seen when airguns are shooting are similar to the numbers seen when the airguns are not shooting (Stone 1997; Stone 1998; Stone 2000; Stone 2001; Stone 2003). However, fin and sei whale sighting rates were higher when airguns were shooting, which may result from their tendency to remain at or near the surface at times of airgun operation (Stone 2003). The analysis of the combined data from all years indicated that baleen whales stayed farther from airguns during periods of shooting (Stone 2003) . Baleen whales also altered course more often during periods of shooting and more were headed away from the vessel at these times, indicating some level of localized avoidance of seismic activity (Stone 2003).

Sperm whales responded to military sonar, apparently from a submarine, by dispersing from social aggregations, moving away from the sound source, remaining relatively silent and becoming difficult to approach (Watkins 1985). Brownell (2004) reported the behavioral responses of western gray whales off the northeast coast of Sakhalin Island to sounds produced by seismic activities in that region. In 1997, the gray whales responded to seismic activities by changing their swimming speed and orientation, respiration rates, and distribution in waters around the seismic surveys. In 2001, seismic activities were conducted in a known feeding area of these whales and the whales left the feeding area and moved to areas farther south in the Sea of Okhotsk. They only returned to the feeding area several days after the seismic activities stopped. The potential fitness consequences of displacing these whales, especially mother-calf pairs and skinny whales, outside of their normal feeding area is not known; however, because gray whales, like other large whales, must gain enough energy during the summer foraging season to last them the entire year, sounds or other stimuli that cause them to abandon a foraging area for several days seems almost certain to disrupt their energetics and force them to make trade-offs like delaying their migration south, delaying reproduction, reducing growth, or migrating with reduced energy reserves.

Captive bottlenose dolphins and a beluga whale exhibited changes in behavior when exposed to 1 second pulsed sounds at frequencies similar to those emitted by the multi-beam sonar that is used by geophysical surveys (Ridgway and Carder 1997; Schlundt et al. 2000b), and to shorter broadband pulsed signals (Finneran et al. 2000a; Finneran et al. 2002a).

Behavioral changes typically involved what appeared to be deliberate attempts to avoid a sound exposure or to avoid the location of the exposure site during subsequent tests (Finneran et al. 2002b; Schlundt et al. 2000b). Dolphins exposed to 1-sec intense tones exhibited short-term changes in behavior above received sound levels of 178 to 193 dB re 1 μParms and belugas did so at received levels of 180 to 196 dB and above. Received levels necessary to elicit such responses to shorter pulses were higher (Finneran et al. 2000a; Finneran et al. 2002a). Test animals sometimes vocalized after exposure to pulsed, mid-frequency sound from a watergun (Finneran et al. 2002b). In some instances, animals exhibited aggressive behavior toward the test apparatus (Ridgway and Carder 1997; Schlundt et al. 2000b). It is not clear whether or to what degree the responses of captive animals might be representative of the responses of marine animals in the wild. For example, wild cetaceans sometimes avoid sound sources well before they are exposed to received levels such as those used in these experiments. Further, the responses of marine animals in the wild may be more subtle than those described by Ridgway et al. (1997) and Schlundt et al. (2000b).

Richardson et al. (1995e) and Richardson and Wursig (1997) used controlled playback experiments to study the response of bowhead whales in Arctic Alaska. In their studies, bowhead whales tended to avoid drill ship noise at estimated received levels of 110 to 115 dB and seismic sources at estimated received levels of 110 to 132 dB. Richardson et al. (1995e) concluded that some marine mammals would tolerate continuous sound at received levels above 120 dB re 1 Pa for a few hours. These authors concluded that most marine mammals would avoid exposures to received levels of continuous underwater noise greater than 140 dB when source frequencies were in the animal's most sensitive hearing range.

Several authors noted that migrating whales are likely to avoid stationary sound sources by deflecting their course slightly as they approached a source (LGL and Greenridge 1987 in Richardson et al. 1995e). Malme et al. (1983; 1984) studied the behavioral responses of gray whales that were migrating along the California coast to various sound sources located in their migration corridor. The whales they studied showed statistically significant responses to four different underwater playbacks of continuous sound at received levels of approximately 120 dB. The sources of the playbacks were typical of a drillship, semi-submersible, drilling platform, and production platform.

Morton et al. (2002) exposed killer whales (Orcinus orca) to sounds produced by acoustic harassment devices (devices that were designed to harass harbor seals, source levels were 194 dB at 10 kHz re 1μ Pa at 1 meter). They concluded that observations of killer whales declined dramatically in the experimental area (Broughton Archipelago) during the time interval the harassment devices had been used (but not before or after the use). Other investigators have concluded that gray whales and humpback whales abandoned some of their coastal habitat in California and Hawai′i, respectively, because of underwater noise associated with extensive vessel traffic (Gard 1974; Reeves 1977; Salden 1988).

Nowacek et al. (2004b) conducted controlled exposure experiments on North Atlantic right whales using ship noise, social sounds of con-specifics, and an alerting stimulus (frequency modulated tonal signals between 500 Hz and 4.5 kHz). Animals were tagged with acoustic sensors (D-tags) that simultaneously measured movement in three dimensions. Whales reacted strongly to alert signals at received levels of 133-148 dB SPL, mildly to conspecific signals, and not at all to ship sounds or actual vessels. The alert stimulus caused whales to immediately cease foraging behavior and swim rapidly to the surface. Several studies have demonstrated that cetaceans will avoid human activities such as vessel traffic, introduced sounds in the marine environment, or both. Lusseau (2003b) reported that bottlenose dolphins in Doubtful Sound, New Zealand, avoided approaching tour boats by increasing their mean diving interval. Male dolphins began to avoid tour boats before the boats were in visible range, while female dolphins only began to avoid the boats when the boats became intrusive (he attributed the differential responses to differences in energetics: the larger body size of male dolphins would allow them to compensate for the energy costs of the avoidance behavior more than female dolphins). Bejder et al. (2006a) studied the effects of vessel traffic on bottlenose dolphins in Shark Bay, Australia, over three consecutive 4.5-year periods. They reported that the dolphins avoided the bay when two tour operators began to operate in the bay.

Marine mammals may avoid or abandon an area temporarily during periods of high traffic or noise, returning when the source of the disturbance declines below some threshold (Allen and Read. 2000; Lusseau 2004). Alternatively, they might abandon an area for as long as the disturbance persists. For example, Bryant et al. (1984 in Polefka 2004) reported that gray whales abandoned a calving lagoon in Baja California, Mexico following the initiation of dredging and increase in small vessel traffic. After the noise-producing activities stopped, the cow-calf pairs returned to the lagoon; the investigators did not report the consequences of that avoidance on the gray whales. Gard (1974) and Reeves (1977) reported that underwater noise associated with vessel traffic had caused gray whales to abandon some of their habitat in California for several years. Salden (1988) suggested that humpback whales avoid some nearshore waters in Hawai′i for the same reason.

As Bejder et al. (2009; 2006a) argued, animals that are faced with human disturbance must evaluate the costs and benefits of relocating to alternative locations; those decisions would be influenced by the availability of alternative locations, the distance to the alternative locations, the quality of the resources at the alternative locations, the conditions of the animals faced with the decision, and their ability to cope with or escape the disturbance (citing Beale and Monaghan 2004a; Beale and Monaghan 2004b; Frid and Dill 2002; Gill and Sutherland 2001; Lima and Dill. 1990). Specifically, animals delay their decision to flee from predators and predatory stimuli that they detect, or until they decide that the benefits of fleeing a location are greater than the costs of remaining at the location or, conversely, until the costs of remaining at a location are greater than the benefits of fleeing (Ydenberg and Dills 1986). Ydenberg and Dill (1986) and Blumstein (2003) presented an economic model that recognized that animals will almost always choose to flee a site over some short distance to a predator; at a greater distance, animals will make an economic decision that weighs the costs and benefits of fleeing or remaining; and at an even greater distance, animals will almost always choose not to flee.

Based on a review of observations of the behavioral responses of 122 minke whales, 2,259 fin whales, 833 right whales, and 603 humpback whales to various sources of human disturbance, Watkins (1986) reported that fin, humpback, minke, and North Atlantic right whales ignored sounds that occurred at relatively low received levels, that had the most energy at frequencies below or above their hearing capacities, or that were from distant human activities, even when those sounds had considerable energies at frequencies well within the whale's range of hearing. Most of the negative reactions that had been observed occurred within 100 m of a sound source or when sudden increases in received sound levels were judged to be in excess of 12 dB, relative to previous ambient sounds From these observations, we would have to conclude that the distance between marine mammals and a source of sound, as well as the received level of the sound itself, will help determine whether individual animals are likely to respond to the sound and engage in avoidance behavior.

At the limits of the range of audibility, endangered and threatened marine mammals are likely to ignore cues that they might otherwise detect. At some distance that is closer to the source, endangered or threatened marine mammals may be able to detect a sound produced by military readiness activities, but they would not devote attentional resources to the sound (that is, they would filter it out as background noise or ignore it). For example, we would not expect endangered or threatened marine mammals that find themselves between 51 and 130 kilometers (between about 32 and 81 miles) from the source of a sonar ping to devote attentional resources to that stimulus, even though received levels might be as high as 140 dB (at 51 kilometers) because those individuals are more likely to be focusing their attention on stimuli and environmental cues that are considerably closer, even if they were aware of the signal. Those animals that are closer to the source and not engaged in activities that would compete for their attentional resources (for example, mating or foraging) might engage in low-level avoidance behavior (changing the direction of their movement to take them away from or tangential to the source of the disturbance) possibly accompanied by short-term vigilance behavior, but they are not likely to change their behavioral state (that is, animals that are foraging or migrating would continue to do so). For example, we would expect endangered or threatened marine mammals that find themselves between 25 and 51 kilometers (between about 15.5 and 32 miles) from a sonar transmission where received levels might range from 140 and 150 dB to engage in low-level avoidance behavior or short-term vigilance behavior, but they are not likely to change their behavioral state as a result of that exposure. At some distance that is closer still, these species are likely to engage in more active avoidance behavior followed by subsequent low-level avoidance behavior that does not bring them closer to the training activity. At the closest distances, we assume that endangered and threatened marine mammals would engage in vertical and horizontal avoidance behavior unless they have a compelling reason to remain in a location (for example, to feed). In some circumstances, this would involve abrupt vertical or horizontal movement accompanied by physiological stress responses.

The evidence available also suggests that marine mammals might experience more severe consequences if an acoustic cue associated with active sonar leads them to perceive they face an imminent threat, but circumstances do not allow them to avoid or escape further exposure. At least six circumstances might prevent an animal from escaping further exposure to mid-frequency active sonar and could produce any of one the following outcomes: 1) when swimming away (an attempted escape) brings marine mammals into a shallow coastal feature that causes them to strand; 2) they cannot swim away because the exposure occurred in a coastal feature that leaves marine mammals no escape route (for example, a coastal embayment or fjord that surrounds them with land on three sides, with the sound field preventing an escape); 3) they cannot swim away because the marine mammals are exposed to multiple sound fields in a coastal or oceanographic feature that act in concert to prevent their escape; 4) they cannot dive below the sound field while swimming away because of shallow depths; 5) to remain below the sound field, they must engage in a series of very deep dives with interrupted attempts to swim to the surface (which might lead to pathologies similar to those of decompression sickness); 6) any combination of these phenomena.

Because many species of marine mammals make repetitive and prolonged dives to great depths, it has long been assumed that marine mammals have evolved physiological mechanisms to protect against the effects of rapid and repeated decompressions. Although several investigators have identified physiological adaptations that may protect marine mammals against nitrogen gas supersaturation (alveolar collapse and elective circulation) (Kooyman et al. 1972; Ridgway and Howard 1979). Ridgway and Howard (1979) reported that bottlenose dolphins (Tursiops truncatus) that were trained to dive repeatedly had muscle tissues that were substantially supersaturated with nitrogen gas. Houser et al. (2001) used these data to model the accumulation of nitrogen gas within the muscle tissue of other marine mammal species and concluded that cetaceans that dive deep and have slow ascent or descent speeds would have tissues that are more supersaturated with nitrogen gas than other marine mammals.

The evidence available suggests that whales are likely to engage in vertical or horizontal avoidance behavior in an attempt to avoid continued exposed to mid-frequency active sonar (or, at least, some components of the sound source), the ships associated with the active sonar, or both. However, the process of avoiding exposures can be costly to marine animals if (a) they are forced to abandon a site that is important to their life history (for example, if they are forced to abandon a feeding or calving area), (b) their flight response disrupts an important life history event (for example, reproduction), or (c) their diving pattern becomes sufficiently erratic, or if they strand or experience higher predation risk during the process of abandoning a site.

If whales respond to a Navy vessel that is transmitting active sonar in the same way that they might respond to a predator, their probability of flight responses should increase when they perceive that Navy vessels are approaching them directly, because a direct approach may convey detection and intent to capture (Burger and Gochfeld 1981; Cooper 1997). The probability of flight responses should also increase as received levels of active sonar increase (and the ship is, therefore, closer) and as ship speeds increase (that is, as approach speeds increase). For example, the probability of flight responses in Dall's sheep *Ovis dalli dalli* (Frid 2003; Frid and Dill 2002), ringed seals Phoca hispida (Born et al. 1999), Pacific brant (*Branta bernicl nigricans*) and Canada geese (B. Canadensis) increased as a helicopter or fixed-wing aircraft approached groups of these animals more directly (Ward et al. 1999). Bald eagles (*Haliaeetus leucocephalus*) perched on trees alongside a river were also more likely to flee from a paddle raft when their perches were closer to the river or were closer to the ground (Steidl and Anthony 1996).

6.7.3.7 ***Non-Impulsive Sound Sources***

Sonar and other non-impulsive sound sources emit sound waves into the water to detect objects, safely navigate, and communicate. Most systems operate within specific frequencies (although some harmonic frequencies may be emitted at lower sound pressure levels). Other sources of non-impulsive noise include acoustic communications, sonar used in navigation, and other sound sources used in testing.

Most use of active acoustic sources involves a single unit or several units (ship, submarine, aircraft, or other platform) employing a single active sonar source in addition to sound sources used for communication, navigation, and measuring oceanographic conditions. Anti-submarine warfare activities may also use an acoustic target or an acoustic decoy.

6.7.3.8 *Anti-Submarine Warfare Sonar*

Sonar used in anti-submarine warfare is deployed on many platforms and are operated in various ways. Anti-submarine warfare active sonar is usually mid-frequency (1–10 kHz) because mid-frequency sound balances sufficient resolution to identify targets and distance within which threats can be identified.

Ship tactical hull-mounted sonar contributes the largest portion of overall non-impulsive sound. Duty cycle can vary from about a ping per minute to continuously active. Sonar can be wide ranging in a search mode or highly directional in a track mode.

A submarine's mission revolves around its stealth; therefore, a submarine's mid-frequency sonar is used infrequently because its use would also reveal a submarine's location.

Aircraft-deployed, mid-frequency, anti-submarine warfare systems include omnidirectional dipping sonar (deployed by helicopters) and omnidirectional sonobuoys (deployed from various aircraft), which have a typical duty cycle of several pings per minute.

Acoustic decoys that continuously emulate broadband vessel sound or other vessel acoustic signatures may be deployed by ships and submarines.

Torpedoes use directional high-frequency sonar when approaching and locking onto a target. Practice targets emulate the sound signatures of submarines or repeat received signals.

Most anti-submarine warfare events occur more than 12 nm from shore and within areas of east coast training ranges designated for anti-submarine warfare activities.

Most events usually occur over a limited area and are completed in less than one day, often within a few hours. Multi-day anti-submarine warfare events requiring coordination of movement and effort between multiple platforms with active sonar over a larger area occur less often, but constitute a large portion of the overall non-impulsive underwater noise that would be impacted by Navy activities. For example, the largest event, a composite training unit exercise, would have periods of concentrated, near-continuous anti-submarine warfare sonar use by several platforms during up to a three-week period-week period.

6.7.3.9 *Mine Warfare Sonar*

Sonar used to locate mines and other small objects is typically high frequency, which provides higher resolution. Mine detection sonar is deployed at variable depths on moving platforms to sweep a suspect mined area (towed by ships, helicopters, or unmanned underwater vehicles). Mid-frequency hull mounted sonar can also be used in an object detection mode known as "Kingfisher" mode. Mine detection sonar use would be concentrated in areas where practice mines are deployed, typically in water depths less than 200 ft. (61 m). Most events usually occur over a limited area and are completed in less than one day, often within a few hours.

6.7.3.10 *Other Active Acoustic Sources*

Active sound sources used for navigation and obtaining oceanographic information (e.g., depth, bathymetry, and speed) are typically directional, have high duty cycles, and cover a wide range of frequencies, from low, mid-frequency to very high frequency. These sources are similar to the navigation systems on standard large commercial and oceanographic vessels. Sound sources used in communications are typically high frequency or very high frequency. These sound sources could be used by vessels during most activities and while transiting throughout the Study Area.

6.8 Risk of Exposures to Non-Impulsive Acoustic Stressors

Most non-impulsive sound sources are used in offshore areas, some use would occur nearshore in inland waters such as bays, at pierside, or during transit in and out of port. These activities include sonar maintenance and testing, object detection/mine countermeasures, and navigation.

Most non-impulsive sound stressors associated with testing events, and about half of non-impulsive sound stressors associated with training events, involve a single unit or several units (ship, submarine, aircraft, or other platform) employing a single active sonar source in addition to sound sources used for communication, navigation, and measuring oceanographic conditions. Anti-submarine warfare activities may also use an acoustic target or an acoustic decoy. These events usually occur over a limited area and are completed in less than one day, often within a few hours.

Multiday anti-submarine warfare events requiring coordination of movement and effort between multiple platforms with active sonar over a larger area occur less often, but constitute a large portion of overall non-impulsive underwater noise imparted by Navy activities. Approximately half of the non-impulsive sound stressors generated during training events occur during multiplatform anti-submarine warfare events.

6.8.1 Risk to Fish

Non-impulsive sources include sonar and other active acoustic sources, vessel noise, and subsonic aircraft noise. Potential acoustic effects to fish from non-impulsive sources may be considered in four categories: (1) direct injury; (2) hearing loss; (3) auditory masking; and (4) physiological stress and behavioral reactions.

Direct injury to fish as a result of exposure to non-impulsive sounds is highly unlikely to occur. Therefore, direct injury as a result of exposure to non-impulsive sound sources is not discussed further in this Opinion.

Research indicates that exposure of fish to transient, non-impulsive sources is unlikely to result in any hearing loss. Most sonar sources are outside of the hearing and sensitivity range of most marine fish, and noise sources such as vessel movement and aircraft overflight lack the duration and intensity to cause hearing loss. Furthermore, PTS has not been demonstrated in fish as they have been shown to regenerate lost sensory hair cells. Therefore, hearing loss as a result of exposure to non-impulsive sound sources is not discussed further in this Opinion.

6.8.2 Exposures to Non-Impulsive Acoustic Stressors from Annual Training Exercises

For this consultation, NMFS considered exposure estimates from the Navy Acoustic Effects Model at several output points for marine mammals and sea turtles. Exposure of fish to acoustic stressors was not modeled due to limited information on species distribution and density in the action area. First, the total number of ESA-listed species (animats) that would be exposed to acoustic sources prior to the application of a dose-response curve or criteria. We term these the "unprocessed" estimates. This estimate is the number of times individual animats or animals are likely to be exposed to the acoustic environment that is a result of training exercises and testing activities, regardless of whether they are "taken" as a result of that exposure. In most cases, the number of animals "taken" by an action would be a subset of the number of animals that are exposed to the action because (1) in some circumstances, animals might not respond to an exposure and (2) some responses may be negative for an individual animal without constituting a form of "take" (for example, some physiological stress responses only have fitness consequences when they are sustained and would only constitute a "take" as a result of cumulative exposure).

A second set of exposure estimates ("model-estimated") of listed species were generated and "processed" using dose-response curves and criteria for temporary and permanent threshold shift developed by the Navy and NMFS' Permits Division for the purpose of identifying harassment pursuant to the MMPA. Neither sets of exposure estimates, the unprocessed or processed, consider standard mitigation actions that NMFS' Permits Division would require under the MMPA rule to avoid marine mammals or that the Navy proposes for marine mammals, nor did the estimates consider any avoidance responses that might be taken by individual animals once they sense the presence of Navy vessels or aircraft.

Lastly, the U.S. Navy applied a third step incorporating Navy mitigation measures (Table 27) as also proposed in the MMPA Rule (see page 51 of the Opinion) species specific avoidance and mitigation to derive the Navy's final MMPA take request. The exposure and response analysis presented in this Opinion considers all three exposure estimates on an annual basis, cumulatively over the five-year period, and cumulatively for the reasonably foreseeable future to derive a final estimate of anticipate levels of take by training and testing activity and species.

6.8.2.1 ***Unprocessed Estimates of Exposure to Non-Impulsive Sound for Annual Training***
Potential exposures (4,918,234.30) of marine mammals to non-impulsive sound from active sonar sources used in training exercises comprise approximately 46% of the estimated 10,647,170.62 unprocessed exposures from non-impulsive sound sources. The following sections will further analyze unprocessed exposures by training activity, species and geographic location.

72.31% of the 4,918,234.30 exposures to non-impulsive sonar occur within the Jacksonville and Charleston Operating Areas, 17.94% occur in the VACAPES Range Complex. The table below provides the relative contribution of sonar exposures by annual training exercise type. We note that an estimated 92% of exposures result from TRACKEX/TORPEX –MPA Sonobuoy, COMPTUEX, JTFEX/SUSTAINEX and TRACKEX/TORPEX –Surface training exercises.

Table 75. Non-Impulsive Sound Contribution by Annual Training Exercise in the AFTT Study Area

Annual Training Exercise	% Raw Exposures by Exercise
COMPTUEX	**23.16%**
Group Sail	3.80%
Mine Neutralization - ROV	0.01%
TRACKEX/TORPEX –MPA Sonobuoy	**43.00%**
Airborne Mine Countermeasure – Mine Detection	0.06%

IAC	0.17%
JTFEX/SUSTAINEX	**9.36%**
Mine Countermeasures Exercise (MCM) – Ship Sonar	0.00%
SEASWITI	0.19%
Submarine Navigational Exercise	0.00%
Submarine Sonar Maintenance	0.94%
Submarine Under Ice Certification	0.03%
Surface Ship Object Detection	0.01%
Surface Ship Sonar Maintenance	2.12%
TRACKEX/TORPEX –Helo	0.27%
TRACKEX/TORPEX –Sub	0.76%
TRACKEX/TORPEX –Surface	**15.96%**
TRACKEX/TORPEX –MPA	0.13%

Relative to the total unprocessed exposures from annual training each year, the sections below summarize the number of modeled exposures (animats) by species.

6.8.2.1.1 Blue Whale

The model output estimates that blue whales will be exposed to sonar and other non-impulsive acoustic stressors associated with training exercises and testing activities throughout the year.

The NAEMO provided an unprocessed estimate of 1,123 blue whale exposure events annually to non-impulsive sounds associated with annual training at levels between 120 and 156 dB SPL and 192 exposure events annually at levels between 157 and 193 dB SPL. No exposures to non-impulsive sounds associated with annual training are expected above 193 dB SPL. Approximately 675 of the total exposures from the largest contributing activities (a subset of the total number of exposures) will occur in JAXOACHOA, 209 in VACAPES, 161 in CPOA, and 96 in NTL (Table 76).

Table 76. Activities that result in the highest percentages of blue whales unprocessed exposures to non-impulsive sounds associated with annual training acoustic sources in the Atlantic Fleet Training and Testing (AFTT) Study Area.

	Largest contributing OPAREAs/ranges			
Species-largest activity contributors to exposure	**JAXOACHOA**	**VACAPES**	**CPOA**	**NTL**
Blue whale exposures	**675**	**209**	**161**	**96**
Surface ship sonar maintenance	54	123	106	20
Submarine sonar maintenance		20		29
COMPTUEX	216		12	
Group sail	36	20	16	
TRACKEX/TORPEX - sub				41
TRACKEX/TORPEX - helo				
JTFEX/SUSTAINEX	246	18		

6.8.2.1.2 Fin Whale

The model output estimates that fin whales will be exposed to sonar and other non-impulsive acoustic stressors associated with training exercises and testing activities throughout the year.

The NAEMO provided an unprocessed estimate of 49,351 fin whale exposure events annually to non-impulsive sounds associated with annual training at levels between 120 and 156 dB SPL and 6,862 exposure events annually at levels between 157 and 211 dB SPL. No exposures to non-impulsive sounds associated with annual training are expected above 211 dB SPL. Approximately 26,750 of the total exposures from the largest contributing activities (a subset of the total number of exposures) will occur in JAXOACHOA, 11,075 in VACAPES, 5,105 in CPOA, 4,833 in NBOA, 2,060 in GOMEX, 1,749 in STL, and 4,055 in NTL (Table 77).

Table 77. Activities that result in the highest percentages of fin whales unprocessed exposures to non-impulsive sounds associated with annual training acoustic sources in the Atlantic Fleet Training and Testing (AFTT) Study Area.

	Largest contributing OPAREAs/ranges						
Species-largest activity contributors to exposure	**JAXOACHOA**	**VACAPES**	**CPOA**	**NBOA**	**NTL**	**GOM EX**	**STL**
Fin whale exposures	**26,750**	**11,075**	**5,105**	**4,833**	**4,055**	**2,060**	**1,749**
Surface ship sonar maintenance	1,275	6,261	3,668		787		530
Submarine sonar maintenance		1,233		3,074	1,182		687
Group sail	1,107	978	675				
COMPTUEX	8,484	1,022				1,922	
JTFEX/SUSTAINEX	13,190	659	382				
IAC	231		292			133	
ASWTDE	913						
TRACKEX/TORPEX - helo	919	219			260		155
TRACKEX/TORPEX - sub		454		1,508	1,826		377

6.8.2.1.3 Humpback Whale

The model output estimates that humpback whales will be exposed to sonar and other non-impulsive acoustic stressors associated with training exercises and testing activities throughout the year.

The NAEMO provided an unprocessed estimate of 15,526 humpback whale exposure events annually to non-impulsive sounds associated with annual training at levels between 120 and 156 dB SPL and 2,660 exposure events annually at levels between 157 and 204 dB SPL. No exposures to non-impulsive sounds associated with annual training are expected above 204 dB SPL. Approximately 12,060 of the total exposures from the largest contributing activities (a subset of the total number of exposures) will occur in JAXOACHOA, 2,269 in CPOA, 2,260 in VACAPES, and 752 in NBOA (Table 78).

Table 78. Activities that result in the highest percentages of humpback whales unprocessed exposures to non-impulsive sounds associated with annual training acoustic sources in the Atlantic Fleet Training and Testing (AFTT) Study Area.

Species-largest Activity Contributors to Exposure	Largest contributing OPAREAs/ranges			
	JAXOACHOA	**CPOA**	**VACAPES**	**NBOA**
Humpback whale exposures	**12,060**	**2,269**	**2,260**	**752**
Surface ship sonar maintenance		1,517	1,107	
Submarine sonar maintenance			213	459
Group sail	633	250	181	
COMPTUEX	4,606	147	302	
TRACKEX/TORPEX - MPA sonobuoy				254
JTFEX/SUSTAINEX	4,991	194	274	

6.8.2.1.4 North Atlantic Right Whale

The model output estimates that North Atlantic right whales will be exposed to sonar and other non-impulsive acoustic stressors associated with training exercises and testing activities throughout the year.

The NAEMO provided an unprocessed estimate of 850 North Atlantic right whale exposure events annually to non-impulsive sounds associated with annual training at levels between 120 and 156 dB SPL and 179 exposure events annually at levels between 157 and 195 dB SPL. No exposures to non-impulsive sounds associated with annual training are expected above 195 dB SPL. Approximately of the total exposures from the largest contributing activities (a subset of the total number of exposures) will occur in JAXOACHOA, 160 in Mayport, 58 in Norfolk, and 52 in VACAPES (Table 79).

Table 79. Activities that result in the highest percentages of North Atlantic right whales unprocessed exposures to non-impulsive sounds associated with annual training acoustic sources in the Atlantic Fleet Training and Testing (AFTT) Study Area.

		Largest contributing OPAREAs/ranges		
Species-largest activity contributors to exposure	**JAXOACHOA**	**Mayport**	**Norfolk**	**VACAPES**
North Atlantic right whale exposures	**640**	**160**	**58**	**52**
Surface ship object detection		148	26	17
Submarine navigation exercise			32	
Group sail				29
TRACKEX/TORPEX -helo	78			
COMPTUEX	259			
JTFEX/SUSTAINEX	204			

6.8.2.1.5 Sei Whale

The model output estimates that sei whales will be exposed to sonar and other non-impulsive acoustic stressors associated with training exercises and testing activities throughout the year.

The NAEMO provided an unprocessed estimate of 116,794 sei whale exposure events annually to non-impulsive sounds associated with annual training at levels between 120 and 156 dB SPL and 15,741 exposure events annually at levels between 157 and 211 dB SPL. No exposures to non-impulsive sounds associated with annual training are expected above 211 dB SPL. Approximately 68,490 of the total exposures from the largest contributing activities (a subset of the total number of exposures) will occur in JAXOACHOA, 22,657 in VACAPES, 15,096 in CPOA, 8,968 in NTL, 5,994 in STL, and 5,773 in NBOA (Table 80).

Table 80. Activities that result in the highest percentages of sei whales unprocessed exposures to non-impulsive sounds associated with annual training acoustic sources in the Atlantic Fleet Training and Testing (AFTT) Study Area.

	Largest contributing OPAREAs/ranges					
Species-largest activity contributors to exposure	**JAXOACHOA**	**VACAPES**	**CPOA**	**NTL**	**STL**	**NBOA**
Sei whale exposures	**68,490**	**22,657**	**15,096**	**8,968**	**5,994**	**5,773**
Surface ship sonar maintenance	4,018	11,862	10,458	1,874		
Submarine sonar maintenance		2,450		2,714	1,776	3,760
Submarine navigation exercise					2,542	
Group sail	2,953	1,489	1,397			
IAC	1,425		1,181			
ASWTDE	3,057					
TRACKEX/TORPEX -helo	1,995	341		501	407	
TRACKEX/TORPEX -sub	1,124	839		3,879	1,269	1,708
COMPTUEX	23,266	3,098	974			
JTFEX/SUSTAINEX	29,988	2,153				

6.8.2.1.6 Sperm Whale

The model output estimates that sperm whales will be exposed to sonar and other non-impulsive acoustic stressors associated with training exercises and testing activities throughout the year.

The NAEMO provided an unprocessed estimate of 268,722 sperm whale exposure events annually to non-impulsive sounds associated with annual training at levels between 120 and 156 dB SPL and 32,062 exposure events annually at levels between 157 and 217 dB SPL. No exposures to non-impulsive sounds associated with annual training are expected above 217 dB SPL. Approximately 129,902 of the total exposures from the largest contributing activities (a subset of the total number of exposures) will occur in JAXOACHOA, 71,091 in VACAPES, 26,229 in NTL, 25,883 in CPOA, 19,253 in NBOA, 14,696 in GOMEX, and 13,649 in STL (Table 81).

Table 81. Activities that result in the highest percentages of sperm whales unprocessed exposures to non-impulsive sounds associated with annual training acoustic sources in the Atlantic Fleet Training and Testing (AFTT) Study Area.

	Largest contributing OPAREAs/ranges						
Species-largest activity contributors to exposure	**JAXOACHOA**	**VACAPES**	**NTL**	**CPOA**	**NBOA**	**GOMEX**	**STL**
Sperm whale exposures	**129,902**	**71,091**	**26,229**	**25,883**	**19,253**	**14,696**	**13,649**
Surface ship sonar maintenance	7,460	35,519	5,538	16,767			3,907
Submarine sonar maintenance		8,255	7,273		11,721		5,321
Group sail	6,230	7,856		3,541			
IAC	2,366			1,886		1,029	
ASWTDE	5,699						
TRACKEX/TORPEX - helo	3,664	1,801	1,679				1,109
TRACKEX/TORPEX – MPA sonobuoy	1,926	1,917			679		
TRACKEX/TORPEX - sub	1,926	3,261	11,738		6,499		3,312
COMPTUEX	45,496	6,691		1,617		13,272	
JTFEX/SUSTAINEX	54,859	4,616		1,085			

6.8.2.1.7 Ringed Seal – Arctic DPS

The model output estimates that ringed seals will be exposed to sonar and other non-impulsive acoustic stressors associated with training exercises and testing activities throughout the year. The NAEMO provided an unprocessed estimate of zero ringed seal exposure events annually to non-impulsive sounds associated with annual training at levels above 120 dB SPL

6.8.2.1.8 Hardshell Sea Turtles

The model output estimates that hardshell sea turtles will be exposed to sonar and other non-impulsive acoustic stressors associated with training exercises and testing activities throughout the year.

The NAEMO provided an unprocessed estimate of 494,085 hardshell sea turtle exposure events annually to non-impulsive sounds associated with annual training at levels between 120 and 156 dB SPL and 13,843 exposure events annually at levels between 157 and 194 dB SPL. No exposures to non-impulsive sounds associated with annual training are expected above 194 dB SPL. Approximately 479,188 of the total exposures from the largest contributing activities (a subset of the total number of exposures) will occur in JAXOACHOA, 18,650 in VACAPES, and 7,557 in CPOA (Table 82).

Table 82. Activities that result in the highest percentages of hardshell sea turtles unprocessed exposures to non-impulsive sounds associated with annual training acoustic sources in the Atlantic Fleet Training and Testing (AFTT) Study Area.

Species-largest activity contributors to exposure	Largest contributing OPAREAs/ranges		
	JAXOACHOA	**VACAPES**	**CPOA**
Hardshell turtle exposures	**479,188**	**18,650**	**7,557**
Group sail	46,013	5,327	3,772
COMPTUEX	348,625	8,396	2,439
JTFEX/SUSTAINEX	84,550	4,927	1,346

6.8.2.1.9 Kemp's Ridley Sea Turtle

The model output estimates that Kemp's ridley sea turtles will be exposed to sonar and other non-impulsive acoustic stressors associated with training exercises and testing activities throughout the year.

The NAEMO provided an unprocessed estimate of 15,968 Kemp's ridley sea turtle exposure events annually to non-impulsive sounds associated with annual training at levels between 120 and 156 dB SPL and 250 exposure events annually at levels between 157 and 187 dB SPL. No exposures to non-impulsive sounds associated with annual training are expected above 187 dB SPL. Approximately 13,922 of the total exposures from the largest contributing activities (a subset of the total number of exposures) will occur in JAXOACHOA and 2,094 in VACAPES (Table 83).

Table 83. Activities that result in the highest percentages of Kemp's ridley sea turtles unprocessed exposures to non-impulsive sounds associated with annual training acoustic sources in the Atlantic Fleet Training and Testing (AFTT) Study Area.

Species-largest activity contributors to exposure	Largest contributing OPAREAs/ranges	
	JAXOACHOA	**VACAPES**
Kemp's ridley sea turtle exposures	**13,922**	**2,094**
Surface ship sonar maintenance		
Submarine sonar maintenance		
Submarine navigation exercise		
Group sail	924	1,148
IAC		
ASWTDE		
TRACKEX/TORPEX -helo		
TRACKEX/TORPEX -sub		
COMPTUEX	11,266	601
JTFEX/SUSTAINEX	1,732	346

6.8.2.1.10 Leatherback Sea Turtle

The model output estimates that leatherback sea turtles will be exposed to sonar and other non-impulsive acoustic stressors associated with training exercises and testing activities throughout the year.

The NAEMO provided an unprocessed estimate of 433,623 leatherback sea turtle exposure events annually to non-impulsive sounds associated with annual training at levels between 120 and 156 dB SPL and 12,538 exposure events annually at levels between 157 and 204 dB SPL. No exposures to non-impulsive sounds associated with annual training are expected above 204 dB SPL. Approximately 393,029 of the total exposures from the largest contributing activities (a subset of the total number of exposures) will occur in JAXOACHOA, 23,652 in VACAPES, 20,509 in CPOA, 6,590 in BATH, and 2,380 in GOMEX (Table 84).

Table 84. Activities that result in the highest percentages of leatherback sea turtles unprocessed exposures to non-impulsive sounds associated with annual training acoustic sources in the Atlantic Fleet Training and Testing (AFTT) Study Area.

Species-largest activity contributors to exposure	Largest contributing OPAREAs/ranges				
	JAXOACHOA	VACAPES	CPOA	BATH	GOMEX
Leatherback sea turtle exposures	**393,029**	**23,652**	**20,509**	**6,590**	**2,380**
Group sail	26,055	2,655	9,698		
COMPTUEX	231,527	13,790	6,590	6,590	2,379
JTFEX/SUSTAINEX	135,446	7,208	4,221		

6.8.2.1.11 Loggerhead Sea Turtle

The model output estimates that loggerhead sea turtles will be exposed to sonar and other non-impulsive acoustic stressors associated with training exercises and testing activities throughout the year.

The NAEMO provided an unprocessed estimate of 686,535 loggerhead sea turtle exposure events annually to non-impulsive sounds associated with annual training at levels between 120 and 156 dB SPL and 19,944 exposure events annually at levels between 157 and 204 dB SPL. No exposures to non-impulsive sounds associated with annual training are expected above 204 dB SPL. Approximately 665,687 of the total exposures from the largest contributing activities (a subset of the total number of exposures) will occur in JAXOACHOA, 27,801 in VACAPES, and 12,842 in CPOA (Table 85).

Table 85. Activities that result in the highest percentages of loggerhead sea turtles unprocessed exposures to non-impulsive sounds associated with annual training acoustic sources in the Atlantic Fleet Training and Testing (AFTT) Study Area.

Species-largest activity contributors to exposure	Largest contributing OPAREAs/ranges		
	JAXOACHOA	VACAPES	CPOA
Loggerhead Sea Turtle Exposures	**665,687**	**27,801**	**12,842**

Group Sail	61,994	7,948	6,155
COMPTUEX	476,913	12,613	4,228
JTFEX/SUSTAINEX	126,779	7,240	2,458

6.8.2.1.12 Unprocessed Exposure Estimates by Annual Training Exercise

The NAEMO model output (based on unprocessed estimates) indicates that six types of annual training exercises accounted for a large majority of exposures to non-impulsive sound sources (Table 86).

Table 86. Percent of unprocessed exposure estimate to non-impulsive sound sources from specific annual training exercises.

Species	Exercise type					
	COMPTUEX	Group sail	JTFEX/ SUSTAINEX	Surface ship sonar maintenance	TRACKEX/ TORPEX - sub	Sub sonar maintenance
Blue whale	22	5	21	25		8
Fin whale	21	5	25	22	8	11
Humpback whale	29	6	30	17		6
North Atlantic right whale	25	7	20	6	5	6
Sei whale	25	4	25	23	7	7
Sperm whale	22	6	20	23	9	11
Ringed seal	--	--	--	--	--	--
Hardshell sea turtle	71	11	18	--	--	--
Kemp's ridley sea turtle	73	14	13	--	--	--
Leatherback sea turtle	58	9	33	--	--	--
Loggerhead sea turtle	70	11	19	--	0	--

6.8.2.2 *Processed Estimates of Exposure to Non-Impulsive Sound for Annual Training*

The adjustments made by the Navy to the model-estimated effects to each species at each applicable step of the post-model quantitative analysis including U.S. Navy mitigation (Table 27) are shown for all of the categories of training. Adjustments to PTS (sonar, other active acoustic sources) are shown. All exposures which were moved out of the zone of injury were counted as TTS; the additions to the predicted TTS are not shown to simplify presentation of results. If a step in the post-model analysis did not apply to a particular species, the species impact box is shaded. Additionally, if a step in the post-model box did not apply to impacts due to a particular training or testing activity that was analyzed separately, the species impact box is also shaded.

Table 87. Processed Estimates for Exposure to Sonar and other Active Acoustic Sources During Annual Training, Permanent Threshold Shift

Species	Permanent Threshold Shift (PTS)			
	Model-Estimated	Pre-Activity	With	Avoidance of

		Avoidance Behavior	Implementation of Mitigation	Repeated Exposures (FINAL PREDICTION)
Cetaceans				
Blue Whale	**1**		**0**	**0**
Fin Whale	**24**		**14**	**1**
Humpback Whale	**14**		**12**	**1**
North Atlantic Right Whale	**0**		**0**	**0**
Sei Whale	**68**		**26**	**1**
Sperm Whale	**0**		**0**	**0**
Pinnipeds				
Ringed Seal	**0**			**0**
Sea Turtles				
Hardshell Turtles	**228**			**11**
Hawksbill Turtle	**0**			**0**
Kemp's Ridley Turtle	**5**			**0**
Leatherback Turtle	**184**			**9**
Loggerhead Turtle	**320**			**16**

6.8.3 Exposures to Non-Impulsive Acoustic Stressors from Non-Annual Training Exercises

As described above, For this consultation, we considered exposure estimates from the Navy Acoustic Effects Model at several output points. First, the total number of ESA-listed species (animats) that would be exposed to acoustic sources prior to the application of a dose-response curve or criteria. We term these the "unprocessed" estimates. A second set of exposure estimates (Model-Estimated) of listed species were generated and "processed" using dose-response curves and criteria for temporary and permanent threshold shift developed by the Navy and NMFS' Permits Division. Lastly, the U.S. Navy applied a third step incorporing Navy mitigation (Table 27) and any pre-avoidance behaviors, and species specific avoidance behavior to derive the Navy's final MMPA take request and NMFS Permits Division's proposed take in the MMPA rule. The analysis presented in this opinion considers all three exposure estimates on an annual basis, cumulatively over five years, and cumulatively for the reasonably foreseeable future.

6.8.3.1 *Unprocessed Estimates of Exposure to Non-Impulsive Sound for Non-Annual Training*

19.07% of the estimated 10.70 exposures from non-impulsive sonar occur within the Cherry Point Operating Area, 44.76% occurs in the Gulf of Mexico Range Complex and 28.16% occurs within the Jacksonville and Charleston Operating Areas. The table below provides the relative contribution of sonar exposures by annual training exercise type. We note that an estimated 100% of exposures result from Civilian Port Defense training exercises.

Table 88. Non-Impulsive Sound Contribution by Non-Annual Training Exercise in the AFTT Study Area

Non-Annual Training Exercise	% Unprocessed Exposures by Exercise
Civilian Port Defense	**100.00%**

Relative to the total unprocessed exposures from non-annual training each year, the sections below summarize the number of modeled exposures (animats) by species.

6.8.3.1.1 Blue Whale

The NAEMO provided an unprocessed estimate of no blue whale exposure events annually to non-impulsive sounds associated with non-annual training at any sound pressure level.

6.8.3.1.2 Fin Whale

The NAEMO provided an unprocessed estimate of zero fin whale exposure events annually to non-impulsive sounds associated with non-annual training at any sound pressure level.

6.8.3.1.3 Humpback Whale

The NAEMO provided an unprocessed estimate of zero humpback whale exposure events annually to non-impulsive sounds associated with non-annual training at any sound pressure level.

6.8.3.1.4 North Atlantic Right Whale

The NAEMO provided an unprocessed estimate of zero North Atlantic right whale exposure events annually to non-impulsive sounds associated with non-annual training at any sound pressure level.

6.8.3.1.5 Sei Whale

The NAEMO provided an unprocessed estimate of zero sei whale exposure events annually to non-impulsive sounds associated with non-annual training at any sound pressure level.

6.8.3.1.6 Sperm Whale

The NAEMO provided an unprocessed estimate of 12 sperm whale exposure events annually to non-impulsive sounds associated with non-annual training at any greater than 120 dB SPL, with five of these between 156 dB SPL and 180 dB SPL. No exposures to non-impulsive sounds associated with annual testing are expected above 180 dB SPL. Exposures are anticipated in CPOA, GOMEX, JAXOACHOA, and NBOA due to Civilian Port Defense.

6.8.3.1.7 Ringed Seal - Arctic DPS

The NAEMO provided an unprocessed estimate of zero ringed seal exposure events annually to non-impulsive sounds associated with non-annual training at any sound pressure level.

6.8.3.1.8 Hardshell Sea Turtles

The NAEMO provided an unprocessed estimate of zero hardshell sea turtle exposure events annually to non-impulsive sounds associated with non-annual training at any sound pressure level.

6.8.3.1.9 Kemp’s Ridley Sea Turtle

The NAEMO provided an unprocessed estimate of zero Kemp’s ridley sea turtle exposure events annually to non-impulsive sounds associated with non-annual training at any sound pressure level.

6.8.3.1.10 Leatherback Sea Turtle

The NAEMO provided an unprocessed estimate of zero leatherback sea turtle exposure events annually to non-impulsive sounds associated with non-annual training at any sound pressure level.

6.8.3.1.11 Loggerhead Sea Turtle

The NAEMO provided an unprocessed estimate of zero loggerhead sea turtle exposure events annually to non-impulsive sounds associated with non-annual training at any sound pressure level.

6.8.3.2 *Processed Estimates of Exposure to Non-Impulsive Sound for Non-Annual Training*

The adjustments made by the Navy to the model-estimated effects to each species at each applicable step of the post-model quantitative analysis are shown for all of the categories of training. Adjustments to PTS (sonar, other active acoustic sources) are shown. All exposures which were moved out of the zone of injury were counted as TTS; the additions to the predicted TTS are not shown to simplify presentation of results. If a step in the post-model analysis did not apply to a particular species, the species impact box is shaded. Additionally, if a step in the post-model box did not apply to impacts due to a particular training or testing activity that was analyzed separately, the species impact box is also shaded.

Table 89. Processed Estimates for Exposure to Sonar and Other Active Acoustic Sources - Civilian Port Defense

Species	Permanent Threshold Shift (PTS)			
	Model-Estimated	Pre-Activity Avoidance Behavior	With Implementation of Mitigation	Avoidance of Repeated Exposures (FINAL PREDICTION)
Cetaceans				
Blue Whale	**0**		**0**	**0**
Fin Whale	**0**		**0**	**0**
Humpback Whale	**0**		**0**	**0**
North Atlantic Right Whale	**0**		**0**	**0**
Sei Whale	**0**		**0**	**0**
Sperm Whale	**0**		**0**	**0**
Pinnipeds				
Ringed Seal	**0**			**0**
Sea Turtles				
Hardshell Turtles	**-**			**-**
Hawksbill Turtle	**-**			**-**
Kemp's Ridley Turtle	**-**			**-**
Leatherback Turtle	**-**			**-**
Loggerhead Turtle	**-**			**-**

6.8.4 Response of Marine Mammals to Non-Impulsive Sound Stressors During Annual and Non-Annual Training Exercises

As discussed in the *Approach to the Assessment* section of this biological opinion, response analyses determine how listed resources are likely to respond after being exposed to an Action's effects on the environment or directly on listed species themselves. For the purposes of consultations on activities involving active sonar, our assessments try to detect the probability of lethal responses, sensory impairment (permanent and temporary threshold shifts and acoustic masking), physiological responses (particular stress responses), behavioral responses, and social responses that might result in reducing the fitness of listed individuals. Our response analyses considered and weighed evidence of adverse consequences, beneficial consequences, or the absence of such consequences.

It is important to acknowledge that there is limited empirical evidence on how endangered or threatened marine animals respond upon being exposed to active sonar and sound pressure waves associated with underwater detonations in natural settings. Therefore, the narratives that follow this introduction summarize the best scientific and commercial data available on the responses of other species to active sonar, sound pressure waves associated with underwater detonations, or other acoustic stimuli. Based on those data, we identify the probable responses of endangered and threatened marine animals to mid-frequency active sonar transmissions.

Table 90. U.S. Navy Predicted Impacts per Year from Annually Recurring Sonar and Other Active Acoustic Training Exercises

Mysticetes	**Behavioral Reaction**	**TTS**	**PTS**
Blue Whale	50	97	0
Fin Whale	1,608	2,880	1
Humpback Whale	514	1,128	1
North Atlantic Right Whale	51	60	0
Sei Whale	3,582	6,604	1
Odontocetes – Sperm Whales			
Sperm Whale	14,311	435	0
Phocid Seals			
Ringed Seal – Arctic DPS	0	0	0

Table 91. U.S. Navy Predicted Impacts per Event for Sonar and Other Active Acoustic Sources Used in the Biennial Training Activity, Civilian Port Defense

Mysticetes	**Behavioral Reaction**	**TTS**	**PTS**
Blue Whale	0	0	0
Fin Whale	0	0	0
Humpback Whale	0	0	0
North Atlantic Right Whale	0	0	0
Sei Whale	0	0	0
Odontocetes – Sperm Whales			
Sperm Whale	**1**	0	0

Phocid Seals			
Ringed Seal – Arctic DPS	0	0	0

6.8.4.1 ***Blue Whale***

Based on the U.S. Navy's exposure models, each year we would expect 147 instances annually in which blue whales might be exposed to active sonar associated with AFTT training exercises and be "taken" as a result of that exposure.

Blue whales are not likely to respond to high-frequency sound sources associated with the proposed training activities because of their hearing sensitivities. Preliminary results from the behavioral response study on the Southern California Range Complex suggest that blue whales not only hear mid-frequency active sonar transmissions, in some cases they respond to those transmissions (Southall et al. 2011). Southall et al. (Southall et al. 2011) reported that blue whales appeared to ignore sonar transmissions at received levels lower than about 150 dB and ignored received levels greater than these when they were engaged in some feeding behavior. In other instances, blue whales engaged in short, avoidance movements when they were engaged in other kinds of feeding behavior (Southall et al. 2011).

Melcón et al. (2012) tested whether mid-frequency active sonar and other anthropogenic noises in the mid-frequency band affected the production of d-calls in blue whales in the Southern California Bight (the same area that Southall et al. conducted their study). Despite being classified as "low-frequency hearing specialists," Melcón et al. (2012) reported that blue whales heard, responded to and changed their behavior in response to sounds in the mid-frequency range. For this outcome to have occurred, it was necessary for the blue whales to hear and devote attentional resources to the sonar, despite its high frequency (relative to their putative hearing sensitivity) and its low received level.

Although Southall et al. (2011) reported that blue whales appeared to ignore sonar transmissions at received levels lower than about 150 dB and ignored received levels greater than these when they were engaged in some feeding behavior, the results produced by Melcón et al. (2012) challenge those conclusions because blue whales produce d-calls while foraging. The blue whales studied by Melcón et al. (2012) responded behaviorally to mid-frequency active sonar at received levels below 120 dB SPL (re: 1 μPa). The proportion of d-calls that occurred in the presence of mid-frequency active sonar at received levels of 85, 95, 105, and 115 dB (re: 1 μPa) was 0.3235 (95 percent CI 0.2283 to 0.4361). The proportion of d-calls that occurred in the presence of non-anthropogenic noise at the same received levels was 0.5089 (95 percent CI 0.4446 to 0.5730). The risk ratio of these proportions is 0.6357 (0.3235/0.5089), suggested that the proportion d-calls in the presence of mid-frequency active sonar was 36.43 percent lower at these received levels.

6.8.4.2 ***Fin Whale***

Based on the U.S. Navy's exposure models, each year we would expect 4,490 instances annually in which fin whales might be exposed to active sonar associated with AFTT training exercises and be "taken" as a result of that exposure.

Fin whales are not likely to respond to high-frequency sound sources associated with the proposed training activities because of their hearing sensitivities. While we recognize that animal hearing evolved separately from animal vocalizations and, as a result, it may be inappropriate to make inferences about an animal's hearing sensitivity from their vocalizations, we have no data on fin whale hearing so we assume that fin whale vocalizations are partially representative of their hearing sensitivities. Those vocalizations include a variety of sounds described as low frequency moans or long pulses in the 10-100 Hz band (Edds 1988; Thompson and Friedl 1982; Watkins 1981b). The most typical signals are very long, patterned sequences of tonal infrasonic sounds in the 15-40 Hz range. Ketten (1997a) reports the frequencies of maximum energy between 12 and 18 Hz. Short sequences of rapid calls in the 30-90 Hz band are associated with animals in social groups (Clark personal observation and McDonald personal communication cited in Ketten 1997). The context for the 30-90 Hz calls suggests that they are used to communicate but do not appear to be related to reproduction. Fin whale moans within the frequency range of 12.5-200 Hz, with pulse duration up to 36 seconds, have been recorded off Chile (Cummings and Thompson 1994). The whale produced a short, 390 Hz pulse during the moan.

6.8.4.3 ***Humpback Whale***

Based on the U.S. Navy's exposure models, each year we would expect 1,643 instances annually in which humpback whales might be exposed to active sonar associated with AFTT training exercises and be "taken" as a result of that exposure.

Humpback whales are not likely to respond to high-frequency sound sources associated with the proposed training activities because of their hearing sensitivities. While we recognize that animal hearing evolved separately from animal vocalizations and, as a result, it may be inappropriate to make inferences about an animal's hearing sensitivity from their vocalizations, we have no data on humpback whale hearing so we assume that humpback whale vocalizations are partially representative of their hearing sensitivities. As discussed in the Status of the Species narrative for humpback whales, these whales produce a wide variety of sounds.

Humpback whales produce sounds less frequently in their summer feeding areas. Feeding groups produce distinctive sounds ranging from 20 Hz to 2 kHz, with median durations of 0.2-0.8 seconds and source levels of 175-192 dB (Thompson et al. 1986b). These sounds are attractive and appear to rally animals to the feeding activity (D'Vincent et al. 1985; Sharpe and Dill 1997). In summary, humpback whales produce at least three kinds of sounds:

1. Complex songs with components ranging from at least 20Hz – 4 kHz with estimated source levels from 144 – 174 dB; these are mostly sung by males on the breeding grounds (Payne and McVay 1971; Winn et al. 1970b)

2. Social sounds in the breeding areas that extend from 50Hz – more than 10 kHz with most energy below 3kHz (Richardson et al. 1995e; Tyack and Whitehead 1983b); and

3 Feeding area vocalizations that are less frequent, but tend to be 20Hz – 2 kHz with estimated source levels in excess of 175 dB re 1 uPa-m (Richardson et al. 1995e; Thompson et al. 1986b). Sounds often associated with possible aggressive behavior by males (Silber 1986b; Tyack 1983b) are quite different from songs, extending from 50 Hz to 10 kHz (or higher), with most

energy in components below 3 kHz. These sounds appear to have an effective range of up to 9 km (Tyack and Whitehead 1983b).

Au et al. (2006b) conducted field investigations of humpback whale songs that led these investigators to conclude that humpback whales have an upper frequency limit reaching as high as 24 kHz. Based on this information, it is reasonable to assume that the active mid-frequency sonar the U.S. Navy would employ during the active sonar training activities the U.S. Navy proposes to conduct in the Action Area are within the hearing and vocalization ranges of humpback whales. There is limited information on how humpback whales are likely to respond upon being exposed to mid-frequency active sonar (most of the information available addresses their probable responses to low-frequency active sonar or impulsive sound sources). Humpback whales responded to sonar in the 3.1–3.6 kHz by swimming away from the sound source or by increasing their velocity (Maybaum 1990; Maybaum 1993). The frequency or duration of their dives or the rate of underwater vocalizations, however, did not change.

Humpback whales have been known to react to low frequency industrial noises at estimated received levels of 115-124 dB (Malme et al. 1985), and to calls of other humpback whales at received levels as low as 102 dB (Frankel et al. 1995). Malme et al. (1985) found no clear response to playbacks of drill ship and oil production platform noises at received levels up to 116 dB re 1 Pa. Studies of reactions to airgun noises were inconclusive (Malme et al. 1985). Humpback whales on the breeding grounds did not stop singing in response to underwater explosions (Payne and McVay 1971). Humpback whales on feeding grounds did not alter short-term behavior or distribution in response to explosions with received levels of about 150 dB re 1 Pa/Hz at 350Hz (Lien et al. 1993; Todd et al. 1996). However, at least two individuals were probably killed by the high-intensity, impulse blasts and had extensive mechanical injuries in their ears (Ketten et al. 1993b; Todd et al. 1996). The explosions may also have increased the number of humpback whales entangled in fishing nets (Todd et al. 1996). Frankel and Clark (1998) showed that breeding humpbacks showed only a slight statistical reaction to playbacks of 60-90 Hz sounds with a received level of up to 190 dB. Although these studies have demonstrated that humpback whales will exhibit short-term behavioral reactions to boat traffic and playbacks of industrial noise, the long-term effects of these disturbances on the individuals exposed to them are not known.

6.8.4.4 *North Atlantic Right Whale*

Based on the U.S. Navy's exposure models, each year we would expect 111 instances annually in which North Atlantic right whales might be exposed to active sonar associated with AFTT training exercises and could be "taken" as a result of that exposure. No direct measurements of right whale hearing have been undertaken (Parks and Clark 2007); However, models based upon right whale auditory anatomy suggest a hearing range of 10 Hz to 22 kHz (Parks et al. 2007b).

6.8.4.5 *Sei Whale*

Based on the U.S. Navy's exposure models, each year we would expect 10,188 instances annually in which sei whales might be exposed to active sonar associated with AFTT training exercises and be "taken" as a result of that exposure.

Like blue and fin whales, sei whales are not likely to respond to high-frequency sound sources associated with the proposed training activities because of their hearing sensitivities. As discussed in the Status of the Species section of this opinion, we have no specific information on the sounds produced by sei whales or their sensitivity to sounds in their environment. Based on their anatomical and physiological similarities to both blue and fin whales, we assume that the hearing thresholds of sei whales will be similar as well and will be centered on low-frequencies in the 10-200 Hz.

6.8.4.6 ***Sperm Whale***

Based on the U.S. Navy's exposure models, each year we would expect 14,749 instances annually in which sperm whales might be exposed to active sonar associated with AFTT training exercises and be "taken" as a result of that exposure.

Although there is no published audiogram for sperm whales, sperm whales would be expected to have good, high frequency hearing because their inner ear resembles that of most dolphins, and appears tailored for ultrasonic (>20 kHz) reception (Ketten 1994). The only data on the hearing range of sperm whales are evoked potentials from a stranded neonate, which suggest that neonatal sperm whales respond to sounds from 2.5 to 60 kHz. Sperm whales vocalize in high- and mid-frequency ranges; most of the energy of sperm whales clicks is concentrated at 2 to 4 kHz and 10 to 16 kHz. Other studies indicate sperm whales' wide-band clicks contain energy between 0.1 and 20 kHz (Goold and Jones 1995; Weilgart and Whitehead 1993b). Ridgway and Carder (Ridgway and Carder 2001) measured low-frequency, high amplitude clicks with peak frequencies at 500 Hz to 3 kHz from a neonate sperm whale.

Based on their hearing sensitivities and vocalizations, the active sonar and sound pressure waves from the underwater detonations (as opposed to the shock waves from underwater detonations) the U.S. Navy proposes to conduct at the Naval Surface Warfare Center might mask sperm whale hearing and vocalizations. There is some evidence of disruptions of clicking and behavior from sonars (Goold 1999; Watkins 1985), pingers (Watkins and Schevill 1975a), the Heard Island Feasibility Test (Bowles et al. 1994b), and the Acoustic Thermometry of Ocean Climate (Costa et al. 1998). Sperm whales have been observed to frequently stop echolocating in the presence of underwater pulses made by echosounders (Watkins and Schevill 1975a). Goold (1999) reported six sperm whales that were driven through a narrow channel using ship noise, echosounder, and fish finder emissions from a flotilla of 10 vessels. Watkins and Scheville (Watkins and Schevill 1975a) showed that sperm whales interrupted click production in response to pinger (6 to 13 kHz) sounds. They also stopped vocalizing for brief periods when codas were being produced by other individuals, perhaps because they can hear better when not vocalizing themselves (Goold and Jones 1995).

Sperm whales have been reported to have reacted to military sonar, apparently produced by a submarine, by dispersing from social aggregations, moving away from the sound source, remaining relatively silent and becoming difficult to approach (Watkins 1985). Captive bottlenose dolphins and a white whale exhibited changes in behavior when exposed to 1 sec pulsed sounds at frequencies similar to those emitted by multi-beam sonar that is used in geophysical surveys (Ridgway and Carder 1997; Schlundt et al. 2000b), and to shorter broadband pulsed signals (Finneran et al. 2000a; Finneran et al. 2002b). Behavioral changes typically involved what appeared to be deliberate attempts to avoid the sound exposure or to avoid the location of the exposure site during subsequent tests (Finneran et al. 2002b; Schlundt et al. 2000b). Dolphins exposed to 1-sec intense tones exhibited short-term changes in behavior above received sound levels of 178 to 193 dB re 1 Pa_{rms} and belugas did so at received levels of 180 to 196 dB and above. Received levels necessary to elicit such reactions to shorter pulses were higher (Finneran et al. 2000a; Finneran et al. 2002b). Test animals sometimes vocalized after exposure to pulsed, mid-frequency sound from a watergun (Finneran et al. 2002b). In some instances, animals exhibited aggressive behavior toward the test apparatus (Ridgway and Carder 1997; Schlundt et al. 2000b). The relevance of these data to free-ranging odontocetes is uncertain. In the wild, cetaceans sometimes avoid sound sources well before they are exposed to the levels listed above, and reactions in the wild may be more subtle than those described by Ridgway et al. (1997) and Schlundt et al. (2000b).

Other studies identify instances in which sperm whales did not respond to anthropogenic sounds. Sperm whales did not alter their vocal activity when exposed to levels of 173 dB re 1 Pa from impulsive sounds produced by 1 g TNT detonators (Madsen and Mohl 2000). Richardson et al. (1995e) citing a personal communication with J. Gordon suggested that sperm whales in the Mediterranean Sea continued calling when exposed to frequent and strong military sonar signals. When Andre et al. (1997) exposed sperm whales to a variety of sounds to determine what sounds may be used to scare whales out of the path of vessels, sperm whales were observed to have startle reactions to 10 kHz pulses (180 dB re 1 Pa at the source), but not to the other sources played to them.

Published reports identify instances in which sperm whales have responded to an acoustic source and other instances in which they did not appear to respond behaviorally when exposed to seismic surveys. Mate et al. (1994) reported an opportunistic observation of the number of sperm whales to have decreased in an area after the start of airgun seismic testing. However, Davis et al. (2000b) noted that sighting frequency did not differ significantly among the different acoustic levels examined in the northern Gulf of Mexico, contrary to what Mate et al. (1994) reported. Sperm whales may also have responded to seismic airgun sounds by ceasing to call during some (but not all) times when seismic pulses were received from an airgun array >300 km away (Bowles et al. 1994b).

A recent study offshore of northern Norway indicated that sperm whales continued to call when exposed to pulses from a distant seismic vessel. Received levels of the seismic pulses were up to 146 dB re 1 μPa peak-to-peak (Madsen et al. 2002). Similarly, a study conducted off Nova Scotia that analyzed recordings of sperm whale sounds at various distances from an active seismic program did not detect any obvious changes in the distribution or behavior of sperm whales (McCall-Howard 1999). Recent data from vessel-based monitoring programs in United Kingdom waters suggest that sperm whales in that area may have exhibited some changes in behavior in the presence of operating seismic vessels (Stone 1997; Stone 1998; Stone 2000; Stone 2001; Stone 2003). However, the compilation and analysis of the data led the author to conclude that seismic surveys did not result in observable effects to sperm whales (Stone 2003). The results from these waters seem to show that some sperm whales tolerate seismic surveys.

These studies suggest that the behavioral responses of sperm whales to anthropogenic sounds are highly variable, but do not appear to result in the death or injury of individual whales or result in reductions in the fitness of individuals involved. Responses of sperm whales to anthropogenic sounds probably depend on the age and sex of animals being exposed, as well as other factors. There is evidence that many individuals respond to certain sound sources, provided the received level is high enough to evoke a response, while other individuals do not.

6.8.5 Response of Sea Turtles to Non-Impulsive Sound Stressors During Annual and Non-Annual Training Exercises

Most impacts are predicted to occur in the Southeast U.S. Continental Shelf Large Marine Ecosystem. A smaller, but notable, portion of impacts are also predicted in the Gulf Stream Open Ocean Area. Sea turtles in the Gulf Stream Open Ocean Area would typically be post-hatchlings, juveniles, or migrating adults, while sea turtles in the Southeast U.S. Continental Shelf Large Marine Ecosystem would typically be foraging adults and juveniles. Because these sound sources would typically be used beyond 12 nm from shore, they are unlikely to impact sea turtles near nesting beaches.

Some sea turtles (37,824) are predicted to experience TTS, which would result in short-term reduced perception of sound within a limited frequency range, lasting from minutes to days, depending on the exposure. Thirty-six (36) sea turtles are predicted to experience PTS due to training with sonar and other active acoustic sources, which would permanently reduce perception of sound within a limited frequency range. This long-term consequence could impact an individual turtle's ability to sense biologically important sounds such as predators or prey, reducing that animal's fitness; however, because most sounds are broadband, a reduction in sensitivity over a small portion of hearing range may not interfere with perception of most sounds.

Cues preceding the commencement of the event (e.g., vessel presence and movement, aircraft overflight) may result in some animals departing the immediate area, even before active sound sources begin transmitting. Avoidance behavior could reduce the sound exposure level experienced by a sea turtle and therefore reduce the likelihood and degree of TTS predicted near sound sources. In addition, PTS and TTS threshold criteria for sea turtles are conservatively based on criteria developed for mid-frequency marine mammals. Therefore, actual TTS impacts are expected to be substantially less than the predicted quantities.

Sea turtles may exhibit short-term behavioral reactions, such as swimming away or diving to avoid the immediate area around a source, although studies examining sea turtle behavioral responses to sound have used impulsive sources, not non-impulsive sources. Pronounced reactions to acoustic stimuli could lead to a sea turtle expending energy and missing opportunities to forage or breed. In most cases, acoustic exposures are intermittent, allowing time to recover from an incurred energetic cost, resulting in no long-term consequence.

Because model-predicted impacts are conservative and most impacts would be short-term, potential impacts are not expected to result in substantial changes to behavior, growth, survival, annual reproductive success, lifetime reproductive success (fitness), or species recruitment, and are not expected to result in population-level impacts.

Within the Study Area, critical habitat has been designated in the marine environment for the following sea turtle species: green sea turtles (waters out to 3 nm around Culebra Island, Puerto Rico, due to their importance as developmental and foraging habitat, hawksbill sea turtles (waters out to 3 nm around Mona and Monito Islands, Puerto Rico, due to their importance as developmental and foraging habitat, and leatherback sea turtles (waters inclusive of the 100 fathom curve shoreward off Sand Point, St. Croix, U.S. Virgin Islands, for mating and migratory access of the turtles to and from the nesting beach. At the time of these critical habitat designations no primary constituent elements were listed to define the critical habitat. Sonar and other active acoustic sources within the hearing range of sea turtles are not proposed for use in the nearshore waters in or near these critical habitats. Any use of these sources near these waters would not result in the destruction or impairment of the habitat to support the foraging and development of green and hawksbill sea turtles or mating and nesting activities for the leatherback sea turtle.

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. The predicted acoustic impacts do not take into account mitigation measures, such as establishing shut-down zones for certain sonar systems

Table 92. Annual Total of Model-Predicted Impacts on Sea Turtles for Training Activities Using Sonar and Other Active Non-Impulsive Acoustic Sources

Sea Turtle Species or Group	Harassment	Injury
	Temporary Threshold Shift	Permanent Threshold Shift
Hardshell Turtles[1]	12,131	11
Kemp's Ridley Turtle	263	0
Loggerhead Turtle	16,624	16
Leatherback Turtle	8,806	9

6.8.6 Response of Fish to Non-Impulsive Sound Stressors During Annual and Non-Annual Training Exercises

Potential responses of ESA-listed fish due to non-impulsive sound during training are expected to be very limited to short-term, minor behavioral reactions, if any exposure.

6.8.6.1 *Atlantic Sturgeon*

While unlikely, due to their preference for shallow, nearshore habitats, Atlantic sturgeon may occur in areas that coincide with training activities involving active sonar, particularly in the Northeast, VACAPES, Navy Cherry Point, and JAX Range Complexes. Atlantic sturgeon may also be exposed to sonar noise during pierside surface ship sonar maintenance activities occurring at Naval Submarine Base in Groton, Connecticut; Norfolk Naval Base in Virginia; Joint Expeditionary Base Little Creek in Norfolk, Virginia; Naval Submarine Base Kings Bay in Georgia; and Naval Base Mayport in Florida. Atlantic sturgeon are unlikely to be able to detect the sound produced by mid- or high-frequency sonar and other active acoustic sources. Therefore, responses to acoustic stressors from these sources are not expected.

Low-frequency active sonar and other active acoustic sources are typically used in deeper water beyond the shelf break, well away from potential Atlantic sturgeon habitat. Nevertheless, Atlantic sturgeon in the open ocean could be exposed to sound within their hearing range. If this did occur, they could experience behavioral reactions, physiological stress, and auditory masking, although these impacts would be expected to be short-term and infrequent based on the low probability of co-occurrence between the activity and species.

6.8.6.2 ***Gulf Sturgeon***

Due to their preference for shallow, nearshore waters (less than 20 ft. [6 m]) (Fox et al. 2000a; Fox et al. 2002), it is unlikely that Gulf sturgeon would encounter any use of mid-frequency active sonar during training activities in the GOMEX Range Complex. It is possible that were Gulf sturgeon present, exposure to mid-frequency active sonar may occur during pierside surface ship maintenance activities occurring at naval ports within the Gulf of Mexico. Gulf sturgeon are unlikely to be able to detect the sound produced by mid- or high-frequency sonar and other active acoustic sources. Therefore, responses to acoustic stressors from these sources are not expected.

Low-frequency active sonar and other active acoustic sources are typically used in deeper water beyond the shelf break, well away from potential Gulf sturgeon habitat. Nevertheless, Gulf sturgeon in the open ocean could be exposed to sound within their hearing range. If this did occur, they could experience behavioral reactions, physiological stress, and auditory masking, although these impacts would be expected to be short-term and infrequent based on the low probability of co-occurrence between the activity and species.

Proposed training activities overlap designated critical habitat for Gulf sturgeon within one mile of the coastline and at pierside locations in the eastern Gulf of Mexico. The primary constituent elements are generally not applicable to the Study Area since they occur within the riverine habitat of the species. The use of non-impulsive sources in Gulf sturgeon critical habitat are unlikely to interfere with the individuals' safe and unobstructed passage between riverine, estuarine and marine habitats. Therefore, non-impulsive sound sources used in proposed training activities are unlikely to affect Gulf sturgeon designated critical habitat.

6.8.6.3 ***Smalltooth Sawfish***

The distribution of the smalltooth sawfish has contracted greatly over the past several decades and is believed to be restricted now primarily to Florida waters (Simpfendorfer 2006; Simpfendorfer and Wiley 2006), as described in Section 3.9.2.5.2 (Habitat and Geographic Range). However, verified encounters over the past 15 years have been noted within the Panama City OPAREA and the Key West Range Complex in the Gulf of Mexico; in the JAX Range Complex along the east coast of the United States; and at the Naval Surface Warfare Center, Panama City Division Testing Range (Simpfendorfer 2006). Typically, smalltooth sawfish prefer nearshore, coastal habitats, but it is not uncommon for larger adults to occur in deeper waters ranging from 230 to 400 ft. (70 to 120 m) in depth (Poulakis and Seitz 2004a; Simpfendorfer 2006).

While unlikely, due to their preference for shallow, nearshore habitats, smalltooth sawfish may occur in areas that coincide with training activities involving active high- and mid-frequency sonar, particularly in the JAX and Key West Range Complexes and in the Panama City OPAREA. Smalltooth sawfish may also be exposed to sonar noise during pierside mid-frequency sonar maintenance activities occurring at the Naval Base Mayport in Jacksonville, Florida and Port Canaveral in Port Canaveral, Florida. Smalltooth sawfish are unlikely to be able to detect the sound produced by mid- or high-frequency sonar and other active acoustic sources. Therefore, responses to acoustic stressors from these sources are not expected.

Low-frequency active sonar is used in the JAX Range Complex and could co-occur with the habitat of the smalltooth sawfish in the deeper waters near and seaward of the continental shelf break. The low frequency sound emitted by these sonars may be within the hearing range of smalltooth sawfish. Consequently, it is possible that exposure to the sound may result in an increase in the stress level of the fish, elicit a behavioral response, or cause auditory masking. However, any exposure to low-frequency active noise would be infrequent and brief.

6.8.7 Exposures to Non-Impulsive Acoustic Stressors from Annual Testing Activities

As described above, for this consultation, we considered exposure estimates from the Navy Acoustic Effects Model at several output points. First, the total number of ESA-listed species (animats) that would be exposed to acoustic sources prior to the application of a dose-response curve or criteria. We term these the “unprocessed” estimates. A second set of exposure estimates of listed species were generated and “processed” using dose-response curves and criteria for temporary and permanent threshold shift developed by the Navy and NMFS’ Permits Division. Lastly, the U.S. Navy applied a third step of incorporated species specific avoidance and mitigation to derive the Navy’s final MMPA take request. The analysis presented in this opinion considers all three exposure estimates on an annual basis, cumulatively over five-years, and cumulatively for the reasonably foreseeable future.

6.8.7.1 *Unprocessed Estimates of Exposure to Non-Impulsive Sound for Annual Testing Activities*

47.32% of the 5,608,135.91 unprocessed exposures to non-impulsive sonar occur during annual testing activities occur within the Key West complex; 18.28% occur within the Jacksonville/Charleston Operating Areas; and 13.01% occur in the VACAPES Range Complex. The table below provides the relative contribution of sonar exposures by annual testing activity type. We note that an estimated 92% of the unprocessed exposures result from Sonobuoy Lot Acceptance Testing (46.66%), Unmanned Vehicle Development and Payload Testing (23.69%), ASW Tracking Test - MPA (21.67%).

Table 93. Non-Impulsive Sound Contribution by Annual Testing Activities in the AFTT Study Area

Annual Testing Activity	% Unprocessed Exposures by Exercise

ASW Tracking Test - Helo	1.14%
ASW Tracking Test - MPA	**21.67%**
MCM Mission Package Testing	0.01%
Mine Countermeasure/Neutralization Testing	0.00%
Sonobuoy Lot Acceptance Testing	**46.66%**
Torpedo (Explosive) Testing	0.00%
ASW Mission Package Testing	0.35%
At-Sea Sonar Testing	0.08%
Combat System Ship Qualification Trials: In-port	0.00%
Combat System Ship Qualification Trials: USW	0.05%
Countermeasure Testing	0.03%
Mine Detection/Classification Testing	0.00%
Pierside Integrated Swimmer Defense	0.00%
Pierside Sonar Testing	0.00%
Special Warfare	0.66%
Submarine Sea Trial	0.79%
Submarine Sonar Testing/Maintenance	1.57%
Surface Combatant Sea Trials: ASW Testing	0.37%
Surface Combatant Sea Trials: Pierside Sonar Testing	0.00%
Surface Ship Sonar Testing/Maintenance	0.20%
Torpedo (Non-Explosive) Testing	0.07%
Unmanned Vehicle Development and Payload Testing	**23.69%**
NSWC: Countermeasure Testing	0.01%
NSWC: Mine Detection and Classification Testing	0.05%
NSWC: Special Warfare Testing	0.00%
NSWC: Stationary Source Testing	0.00%
NSWC: UUV Testing	0.11%
NUWC: Pierside Integrated Swimmer Defense	0.00%
NUWC: Semi-Stationary Equipment Testing	0.01%
NUWC: Torpedo Testing	0.00%
NUWC: Towed Equipment Testing	0.01%
NUWC: UUV Testing	0.00%
SFOMF: Mine RDT&E Operations/MCM Testing	0.00%
SFOMF: Signature Analysis Activities	0.25%
SFOMF: Surface Testing Activities	1.46%
SFOMF: Subsurface Testing Activities	0.00%
Airborne Mine Hunting Test	0.00%
ASW Torpedo Test	0.71%
Kilo Dip	0.06%

Relative to the total unprocessed exposures from annual testing activities each year, the sections below summarize the number of modeled exposures (animats) by species.

6.8.7.1.1 Blue Whale

The NAEMO provided an unprocessed estimate of 2,205 blue whale exposure events annually to non-impulsive sounds associated with annual testing at levels between 120 and 156 dB SPL and 57 exposure events annually at levels between 157 and 174 dB SPL. No exposures to non-impulsive sounds associated with annual testing are expected above 174 dB SPL. Approximately 921 of these exposures will occur in VACAPES, 410 in JAXOACHOA, and 298 in NBOA (Table 94).

Table 94. Activities that result in the highest percentages of blue whales unprocessed exposures to non-impulsive sounds associated with annual testing acoustic sources in the Atlantic Fleet Training and Testing (AFTT) Study Area.

Species-largest activity contributors to exposure	Largest contributing OPAREAs/ranges		
	VACAPES	JAXOACHOA	NBOA
Blue whale exposures	**921**	**410**	**298**
Submarine sonar testing/ maintenance	150		
Surface ship sonar testing/ maintenance	150		
ASW tracking test - helo	170		
Unmanned vehicle development and payload testing	174	199	201
ASW torpedo testing	104		
ASW tracking test - MPA	92	113	45

6.8.7.1.2 Fin Whale

The NAEMO provided an unprocessed estimate of 114,274 fin whale exposure events annually to non-impulsive sounds associated with annual testing at levels between 120 and 156 dB SPL and 2,813 exposure events annually at levels between 157 and 190 dB SPL. No exposures to non-impulsive sounds associated with annual testing are expected above 190 dB SPL. Approximately 45,499 of these exposures will occur in VACAPES, 33,784 in NBOA, 19,386 in the BRC, 7,044 in JAXOACHOA, 4,470 in GOMEX, and 4,356 in CPOA (Table 95).

Table 95. Activities that result in the highest percentages of fin whales unprocessed exposures to non-impulsive sounds associated with annual testing acoustic sources in the Atlantic Fleet Training and Testing (AFTT) Study Area.

Species-largest activity contributors to exposure	Largest contributing OPAREAs/ranges					
	VACAPES	NBOA	BRC	JAXOACHOA	GOMEX	CPOA
Fin whale exposures	**45,499**	**33,784**	**19,386**	**7,044**	**4,470**	**4,356**
Submarine sonar testing/ maintenance	7,349		3,270			
Surface ship sonar testing/ maintenance	7,349		3,270			
Surface combatant sea trials: ASW			1,773		492	
ASW tracking test - helo	5,538	1,998				
Unmanned vehicle development and payload testing	7,429	20,880		2,495	2,583	2,642
ASW tracking test - MPA	9.760	8,294	10,613	2,761	1,293	1,705
ASW torpedo testing	3,584					
ASW mission package testing	1,489			744		
Submarine sea trial	1,555	1,851				

6.8.7.1.3 Humpback Whale

The NAEMO provided an unprocessed estimate of 37,812 humpback whale exposure events annually to non-impulsive sounds associated with annual testing at levels between 120 and 156 dB SPL and 1,073 exposure events annually at levels between 157 and 187 dB SPL. No exposures to non-impulsive sounds associated with annual testing are expected above 187 dB

SPL. Approximately 9,010 of these exposures will occur in VACAPES, 4,719 in NBOA, 4,635 in JAXOACHOA, and 667 in BRC (Table 96).

Table 96. Activities that result in the highest percentages of humpback whales unprocessed exposures to non-impulsive sounds associated with annual testing acoustic sources in the Atlantic Fleet Training and Testing (AFTT) Study Area.

Species-largest activity contributors to exposure	Largest contributing OPAREAs/ranges			
	VACAPES	**NBOA**	**JAXOACHOA**	**BRC**
Humpback whale exposures	**9,010**	**4,719**	**4,635**	**667**
Submarine sonar testing/ maintenance	1,364			229
Surface ship sonar testing/ maintenance	1,364			229
ASW tracking test - helo	1,255	307		
Unmanned vehicle development and payload testing	1,530	2,896	1,553	
ASW tracking test - MPA	2,037	931	2,240	135
Torpedo (non-explosive) testing			67	54
ASW mission package testing	290		183	
Countermeasure testing		146		
Submarine sea trial	314	389	106	

6.8.7.1.4 North Atlantic Right Whale

The NAEMO provided an unprocessed estimate of 11,088 North Atlantic right whale exposure events annually to non-impulsive sounds associated with annual testing at levels between 120 and 156 dB SPL and 659 exposure events annually at levels between 157 and 174 dB SPL. No exposures to non-impulsive sounds associated with annual testing are expected above 174 dB SPL. Approximately 10,119 of these exposures will occur in the BRC due to submarine and surface ship sonar testing/maintenance and ASW mission package testing.

6.8.7.1.5 Sei Whale

The NAEMO provided an unprocessed estimate of 175,831 sei whale exposure events annually to non-impulsive sounds associated with annual testing at levels between 120 and 156 dB SPL and 3,547 exposure events annually at levels between 157 and 193 dB SPL. No exposures to non-impulsive sounds associated with annual testing are expected above 193 dB SPL. Approximately 78,441 of these exposures will occur in VACAPES, 35,703 in NBOA, 23,626 in JAXOACHOA, 12,476 in CPOA, 8,302 in GOMEX, 7,611 in Key West, and 6,739 in BRC (Table 97).

Table 97. Activities that result in the highest percentages of sei whales unprocessed exposures to non-impulsive sounds associated with annual testing acoustic sources in the Atlantic Fleet Training and Testing (AFTT) Study Area.

Species-largest activity contributors to exposure	Largest contributing OPAREAs/ranges

	VACAPES	NBOA	JAXOA CHOA	CPOA	GOMEX	Key West	BRC
Sei whale exposures	**78,441**	**35,703**	**23,626**	**12,476**	**8,302**	**7,611**	**6,739**
Submarine sonar testing/ maintenance	14,621						651
Surface ship sonar testing/ maintenance	14,621						651
Surface combatant sea trials: ASW	475				388		3,159
ASW tracking test - helo	9,047	1,888	758		278		
Unmanned vehicle development and payload testing	14,120	23,325	10,395	9,162	2,100		
ASW tracking test - MPA	12,563	7,734	9,912	3,282	5,464		2,207
ASW torpedo testing	5,721						
Sonobuoy lot acceptance test						7,341	
ASW mission package testing	2,991						
Submarine sea trial	2,974	2,198	1,042				

6.8.7.1.6 Sperm Whale

The NAEMO provided an unprocessed estimate of 558,608 sperm whale exposure events annually to non-impulsive sounds associated with annual testing at levels between 120 and 156 dB SPL and 11,341 exposure events annually at levels between 157 and 194 dB SPL. No exposures to non-impulsive sounds associated with annual testing are expected above 194 dB SPL. Approximately 310,790 of these exposures will occur in VACAPES, 89,448 in NBOA, 61,795 in JAXOACHOA, 28,010 in Key West, 25,149 in CPOA, 24,956 in GOMEX, and 16,635 in BRC (Table 98).

Table 98. Activities that result in the highest percentages of sperm whales unprocessed exposures to non-impulsive sounds associated with annual testing acoustic sources in the Atlantic Fleet Training and Testing (AFTT) Study Area.

Species-largest activity contributors to exposure	Largest contributing OPAREAs/ranges						
	VACAPES	NBOA	JAXOA CHOA	Key West	CPOA	GOMEX	BRC
Sperm whale exposures	**310,790**	**89,448**	**61,795**	**28,010**	**25,149**	**24,956**	**16,635**
Submarine sonar testing/ maintenance	44,393						1,662
Surface ship sonar testing/ maintenance	44,393						1,662
Surface combatant sea trials: ASW	1,442		638			685	8,472
ASW tracking test - helo	38,915	5,146	1,996			784	
Unmanned vehicle development and payload testing	50,020	50,723	24,102		17,715	5,507	
ASW tracking test - MPA	74,410	23,332	24,389		7,355	17,870	4,654
ASW torpedo testing	30,295		974				
Sonobuoy lot acceptance test				27,286			

ASW mission package testing	8,558		4,789				
Submarine sea trial	12,943	8,720	2,841				

6.8.7.1.7 Ringed Seal – Arctic DPS

The NAEMO provided an unprocessed estimate of 124,702 ringed seal exposure events annually to non-impulsive sounds associated with annual testing at levels between 120 and 156 dB SPL and 5,286 exposure events annually at levels between 157 and 192 dB SPL. No exposures to non-impulsive sounds associated with annual testing are expected above 192 dB SPL. Almost all of these exposures stem from MPA ASW track testing (93,507 exposures) or submarine or surface ship sonar maintenance (18,072, respectively).

6.8.7.1.8 Hardshell Sea Turtles

The NAEMO provided an unprocessed estimate of 2,028,740 hardshell sea turtle exposure events annually to non-impulsive sounds associated with annual testing at levels between 120 and 156 dB SPL and 21,075 exposure events annually at levels between 157 and 195 dB SPL. No exposures to non-impulsive sounds associated with annual testing are expected above 195 dB SPL. Approximately 1,401,976 of these exposures will occur in Key West, 306,687 in JAXOACHOA, 136,794 in NBOA, 109,304 in VACAPES, 44,911 in SFOMF, and 44,194 in CPOA (Table 99).

Table 99. Activities that result in the highest percentages of hardshell sea turtles unprocessed exposures to non-impulsive sounds associated with annual testing acoustic sources in the Atlantic Fleet Training and Testing (AFTT) Study Area.

Species-largest activity contributors to exposure	Largest contributing OPAREAs/ranges					
	Key West	JAXOA CHOA	NBOA	VACAPES	SFOMF	CPOA
Hardshell turtle exposures	**1,401,976**	**306,687**	**136,794**	**109,304**	**44,911**	**44,194**
Surface combatant sea trials: ASW		678				
Unmanned vehicle development and payload testing		148,831	97,657	37,059		30,707
ASW tracking test - MPA	1,383,754	155,258	37,530	70,048		13,487
Special warfare	18,223					
Signature analysis activities					6,491	
Surface testing activities					38,421	
Submarine sea trial		1,919		1,606		

6.8.7.1.9 Kemp's Ridley Sea Turtle

The NAEMO provided an unprocessed estimate of 41,552 Kemp's ridley sea turtle exposure events annually to non-impulsive sounds associated with annual testing at levels between 120 and 156 dB SPL and 525 exposure events annually at levels between 157 and 184 dB SPL. No exposures to non-impulsive sounds associated with annual testing are expected above 184 dB SPL. Approximately 18,026 of these exposures will occur in NBOA, 16,295 in VACAPES, 4,094 in JAXOACHOA, 2,756 in SFOMF, and 769 in CPOA (Table 100).

Table 100. Activities that result in the highest percentages of Kemp's ridley sea turtles unprocessed exposures to non-impulsive sounds associated with annual testing acoustic sources in the Atlantic Fleet Training and Testing (AFTT) Study Area.

Species-largest activity contributors to exposure	Largest contributing OPAREAs/ranges				
	NBOA	VACAPES	JAXOACHOA	SFOMF	CPOA
Kemp's ridley sea turtle exposures	**18,026**	**16,295**	**4,094**	**2,756**	**769**
Unmanned vehicle development and payload testing	12,752	4,229	2,026		538
ASW tracking test - MPA	5,090	11,750	2,036		231
Signature analysis activities				433	
Subsurface testing activities				2,322	
Submarine sea trial		106			

6.8.7.1.10 Leatherback Sea Turtle

The NAEMO provided an unprocessed estimate of 547,428 leatherback sea turtle exposure events annually to non-impulsive sounds associated with annual testing at levels between 120 and 156 dB SPL and 4,203 exposure events annually at levels between 157 and 195 dB SPL. No exposures to non-impulsive sounds associated with annual testing are expected above 195 dB SPL. Approximately 237,650 of these exposures will occur in JAXOACHOA, 150,832 in CPOA, 72,786 in VACAPES, 42,214 in NBOA, 26,376 in Key West, and 14,905 in GOMEX (Table 101).

Table 101. Activities that result in the highest percentages of leatherback sea turtles unprocessed exposures to non-impulsive sounds associated with annual testing acoustic sources in the Atlantic Fleet Training and Testing (AFTT) Study Area.

Species-largest activity contributors to exposure	Largest contributing OPAREAs/ranges					
	JAXOA CHOA	CPOA	VACAPES	NBOA	Key West	GOMEX
Leatherback turtle exposures	**237,650**	**150,832**	**72,786**	**42,214**	**26,376**	**14,905**
Submarine sonar testing/ maintenance			311			
Surface ship sonar testing/ maintenance			311			
Surface combatant sea trials: ASW	292					325
Unmanned vehicle development and payload testing	93,932	111,750	29,259	29,653		11,387
ASW tracking test - MPA	142,188	39,082	42,430	12,197		3,193
Special warfare					586	
Sonobuoy lot acceptance test					25,790	
Submarine sea trial	1,239			364		

6.8.7.1.11 Loggerhead Sea Turtle

The NAEMO provided an unprocessed estimate of 2,415,278 loggerhead sea turtle exposure events annually to non-impulsive sounds associated with annual testing at levels between 120 and 156 dB SPL and 24,951 exposure events annually at levels between 157 and 188 dB SPL.

No exposures to non-impulsive sounds associated with annual testing are expected above 188 dB SPL. Approximately 1,457,626 of these exposures will occur in Key West, 431,477 in JAXOACHOA, 216,025 in NBOA, 181,826 in VACAPES, 82,581 in CPOA, 54,866 in SFOMF, and 9,625 in GOMEX (Table 102).

Table 102. Activities that result in the highest percentages of loggerhead sea turtles unprocessed exposures to non-impulsive sounds associated with annual testing acoustic sources in the Atlantic Fleet Training and Testing (AFTT) Study Area.

Species-largest activity contributors to exposure	Largest contributing OPAREAs/ranges						
	Key West	JAXOA CHOA	NBOA	VACAPES	CPOA	SFOMF	GOMEX
Loggerhead sea turtle exposures	**1,457,626**	**431,477**	**216,025**	**181,826**	**82,581**	**54,866**	**9,625**
Submarine sonar testing/ maintenance				794			
Surface testing activities						46,792	
Surface combatant sea trials: ASW		869		346			190
Signature analysis activities						8,074	
Unmanned vehicle development and payload testing		207,011	159,528	67,794	59,763		9,009
ASW tracking test - MPA		221,024	54,179	110,611	22,818		426
Surface ship sonar testing/ maintenance				794			
Sonobuoy lot acceptance test	1,439,567						
Special warfare	18,060						
Submarine sea trial		2,572	2,318	1,487			

6.8.7.1.12 Non-Impulsive Sound Sources from Annual Testing Activities

The NAEMO model output (based on unprocessed estimates) indicates that six types of testing activities accounted for the majority of exposures to non-impulsive sound sources.

Table 103. Proportion of unprocessed exposure estimate to non-impulsive sound sources from specific annual testing activities.

Species	Testing Activity type					
	MPA ASW tracking test	Helo ASW tracking test	Sub sonar testing/ maintenance	Unmanned vehicle development and payload testing	Sonobuoy Lot Acceptance Test	Surface ship sonar testing/ maintenance
Blue whale	18	10	8	33	6	8
Fin whale	30	7	9	31	1	9
Humpback whale	45	5	11	19	1	11
North Atlantic right whale	52	0	19	3	0	19
Sei whale	24	7	9	33	4	9
Sperm whale	28	8	8	26	5	8
Ringed seal – Arctic DPS	72	0	14	0	0	14

Hardshell sea turtle	14	0	0	15	68	0
Kemp's ridley sea turtle	46	0	0	47	0	0
Leatherback sea turtle	44	0	0	50	5	0
Loggerhead sea turtle	17	0	0	21	59	0

6.8.7.2 ***Processed Estimates of Exposure to Non-Impulsive Sound for Annual Testing***

The following table provides the Model-Estimated exposures and further processed exposures considering Navy mitigation measures (Table 27) and natural avoidance behaviors of species to derive a final exposure estimates for levels that could result in PTS. Higher level effects such as slight lung injury and mortality are not anticipated from non-impulsive sound stressors. Additionally, Behavioral and TTS-level impacts are not included, since Navy mitigation and avoidance behaviors are unpredictable at distances (range to effects) that behavioral impacts and TTS would be expected.

Table 104. Processed Estimates for Exposure to Sonar and Other Active Acoustic Sources - Annual Testing

Species	Permanent Threshold Shift (PTS)			
	Model-Estimated	Pre-Activity Avoidance Behavior	Implementation of Mitigation	Avoidance of Repeated Exposures (FINAL PREDICTION)
Cetaceans				
Blue Whale	**0**		**0**	**0**
Fin Whale	**2**		**1**	**0**
Humpback Whale	**1**		**1**	**0**
North Atlantic Right Whale	**0**		**0**	**0**
Sei Whale	**2**		**1**	**0**
Sperm Whale	**4**		**3**	**0**
Pinnipeds				
Ringed Seal – Arctic DPS	**0**			**0**
Sea Turtles				
Hardshell Turtles	**6**			**0**
Hawksbill Turtle	**0**			**0**
Kemp's Ridley Turtle	**0**			**0**
Leatherback Turtle	**2**			**0**
Loggerhead Turtle	**8**			**0**

6.8.8 Exposures to Non-Impulsive Acoustic Stressors from Non-Annual Testing Activities

As described above, For this consultation, we considered exposure estimates from the Navy Acoustic Effects Model at several output points. First, the total number of ESA-listed species (animats) that would be exposed to acoustic sources prior to the application of a dose-response curve or criteria. We term these the "unprocessed" estimates. A second set of exposure estimates of listed species were generated and "processed" using dose-response curves and criteria for temporary and permanent threshold shift developed by the Navy and NMFS' Permits

Division. Lastly, the U.S. Navy applied a third step of incorporated species specific avoidance and mitigation to derive the Navy's final MMPA take request. The analysis presented in this opinion considers all three exposure estimates on an annual basis, cumulatively over five years, and cumulatively for the reasonably foreseeable future.

6.8.8.1 *Unprocessed Exposures to Non-Impulsive Sound Stressors from Non-Annual Testing Activities*

82.42% of the estimated 120,789.72 exposures from non-impulsive sonar used during non-annual testing would occur at the South Florida Ocean Measurement Facility while 15.92% would occur at the Panama City facility. The table below provides the relative contribution of sonar exposures by non-annual testing activity type. We note that an estimated approximately100% of exposures result from UUV Demonstrations at various facilities.

Table 105. Non-Impulsive Sound Contribution by Non-Annual Testing Activities in the AFTT Study Area

Annual Training Exercise	% Unprocessed Exposures by Exercise
NUWC: UUV Demonstration	1.67%
NSWC: UUV Demonstration	15.92%
SFOMF: UUV Demonstration	82.42%

Relative to the total unprocessed exposures from non-annual testing activities each year, the sections below summarize the number of modeled exposures (animats) by species.

6.8.8.1.1 Blue Whale

The NAEMO provided an unprocessed estimate of 49 blue whale exposure events annually to non-impulsive sounds associated with non-annual testing at levels between 120 and 156 dB SPL and five exposure events annually at levels between 157 and 161 dB SPL. No exposures to non-impulsive sounds associated with non-annual testing are expected above 161 dB SPL. Approximately 20 of these exposures will occur in the Panama City range, four in RIW, and 30 in SFOMF, all resulting from UUV demonstration in each of these locations.

6.8.8.1.2 Fin Whale

The NAEMO provided an unprocessed estimate of 1,202 fin whale exposure events annually to non-impulsive sounds associated with non-annual testing at levels between 120 and 156 dB SPL and 98 exposure events annually at levels between 157 and 186 dB SPL. No exposures to non-impulsive sounds associated with non-annual testing are expected above 186 dB SPL. Approximately 997 of these exposures will occur in the Panama City Range and 293 in RIW, both due to UUV demonstration.

6.8.8.1.3 Humpback Whale

The NAEMO provided an unprocessed estimate of 131 humpback whale exposure events annually to non-impulsive sounds associated with non-annual testing at levels between 120 and 156 dB SPL and 19 exposure events annually at levels between 157 and 168 dB SPL. No exposures to non-impulsive sounds associated with non-annual testing are expected above 168 dB SPL. Approximately 89 of these exposures will occur in the Panama City Range, 39 in SFOMF, and 21 in RIW, all due to UUV demonstration.

6.8.8.1.4 North Atlantic Right Whale

The NAEMO provided an unprocessed estimate of 373 North Atlantic right whale exposure events annually to non-impulsive sounds associated with non-annual testing at levels between 120 and 156 dB SPL and 25 exposure events annually at levels between 157 and 173 dB SPL. No exposures to non-impulsive sounds associated with non-annual testing are expected above 173 dB SPL. Approximately 355 of these exposures will occur in the RIW and 43 in Panama City Range, all resulting from UUV demonstration in each of these locations.

6.8.8.1.5 Sei Whale

The NAEMO provided an unprocessed estimate of 1,066 sei whale exposure events annually to non-impulsive sounds associated with non-annual testing at levels between 120 and 156 dB SPL and 94 exposure events annually at levels between 157 and 186 dB SPL. No exposures to non-impulsive sounds associated with non-annual testing are expected above 186 dB SPL. Approximately 727 of these exposures will occur in the Panama City Range and 424 in SFOMF, all resulting from UUV demonstration in each of these locations.

6.8.8.1.6 Sperm Whale

The NAEMO provided an unprocessed estimate of 2,418 sperm whale exposure events annually to non-impulsive sounds associated with non-annual testing at levels between 120 and 156 dB SPL and 424 exposure events annually at levels between 157 and 192 dB SPL. No exposures to non-impulsive sounds associated with non-annual testing are expected above 192 dB SPL. Approximately 1,579 of these exposures will occur in the Panama City Range and 1,238 in SFOMF, both due to UUV demonstration.

6.8.8.1.7 Ringed Seal – Arctic DPS

The NAEMO provided an unprocessed estimate of 24 ringed seal exposure events annually to non-impulsive sounds associated with non-annual testing at levels between 120 and 156 dB SPL and three exposure events annually at levels between 157 and 180 dB SPL. No exposures to non-impulsive sounds associated with non-annual testing are expected above 180 dB SPL. All of these exposures will occur in the RIW resulting from UUV demonstration.

6.8.8.1.8 Hardshell Sea Turtles

The NAEMO provided an unprocessed estimate of 47,163 hardshell sea turtle exposure events annually to non-impulsive sounds associated with non-annual testing at levels between 120 and 156 dB SPL and 3,773 exposure events annually at levels between 157 and 195 dB SPL. No exposures to non-impulsive sounds associated with non-annual testing are expected above 195 dB SPL. Approximately 46,571 of these exposures will occur in the SFOMF, 3,959 in Panama City, and 406 in RIW, all resulting from UUV demonstration in each of these locations.

6.8.8.1.9 Kemp's Ridley Sea Turtle

The NAEMO provided an unprocessed estimate of 2,713 Kemp's ridley sea turtle exposure events annually to non-impulsive sounds associated with non-annual testing at levels between 120 and 156 dB SPL and 268 exposure events annually at levels between 157 and 184 dB SPL.

No exposures to non-impulsive sounds associated with non-annual testing are expected above 184 dB SPL. Approximately 2,815 of these exposures will occur in the SFOMF and 167 in the RIW, all resulting from UUV demonstration in each of these locations.

6.8.8.1.10 Leatherback Sea Turtle

The NAEMO provided an unprocessed estimate of 5,503 leatherback sea turtle exposure events annually to non-impulsive sounds associated with non-annual testing at levels between 120 and 156 dB SPL and 215 exposure events annually at levels between 157 and 179 dB SPL. No exposures to non-impulsive sounds associated with non-annual testing are expected above 179 dB SPL. Approximately 3,614 of these exposures will occur in the Panama City Range, 1,940 in SFOMF, and 164 in RIW, all resulting from UUV demonstration in each of these locations.

6.8.8.1.11 Loggerhead Sea Turtle

The NAEMO provided an unprocessed estimate of 62,244 loggerhead sea turtle exposure events annually to non-impulsive sounds associated with non-annual testing at levels between 120 and 156 dB SPL and 4,716 exposure events annually at levels between 157 and 187 dB SPL. No exposures to non-impulsive sounds associated with non-annual testing are expected above 187 dB SPL. Approximately 56,717 in SFOMF, 9,663 in Panama City, and 579 in RIW, all due to UUV demonstration.

6.8.8.1.12 Non-Impulsive Sound Sources from Non-Annual Testing Activities

Table 106. Proportion of unprocessed exposure estimate to non-impulsive sound sources from specific non-annual testing activities.

Species	Testing activity		
	NUWC: UUV demonstration	**NSWC: UUV demonstration**	**SFOMF: UUV demonstration**
Blue whale	7	40	56
Fin whale	23	77	1
Humpback whale	14	60	26
North Atlantic right whale	89	11	--
Sei whale	1	63	37
Sperm whale	1	56	44
Ringed seal – Arctic DPS	100	--	--
Hardshell sea turtle	1	8	91
Kemp's ridley sea turtle	6	--	94
Leatherback sea turtle	3	63	34
Loggerhead sea turtle	1	14	85

6.8.8.2 *Processed Estimates of Exposure to Non-Impulsive Sound for Non-Annual Testing*

The following tables (Table 107, Table 108, Table 109, Table 110) provide the Model-Estimated exposures and further processed exposures considering Navy mitigation measures (Table 27) and natural avoidance behaviors of species to derive a final exposure estimates for levels that could result in PTS. Higher level effects such as slight lung injury and mortality are not anticipated from non-impulsive sound stressors. Additionally, Behavioral and TTS-level impacts are not included, since Navy mitigation and avoidance behaviors are unpredictable at distances (range to effects) that behavioral impacts and TTS would be expected.

Table 107. Processed Estimates for Exposure to Sonar and Other Active Acoustic Sources – Naval Surface Warfare Center, Panama City Division: Unmanned Underwater Vehicles Demonstration

Species	Permanent Threshold Shift (PTS)			
	Model-Estimated	Pre-Activity Avoidance Behavior	With Implementation of Mitigation	Avoidance of Repeated Exposures (FINAL PREDICTION)
Cetaceans				
Blue Whale	0		0	0
Fin Whale	0		0	0
Humpback Whale	0		0	0
North Atlantic Right Whale	0		0	0
Sei Whale	0		0	0
Sperm Whale	0		0	0
Pinnipeds				
Ringed Seal – Arctic DPS	0			0
Sea Turtles				
Hardshell Turtles	-			-
Hawksbill Turtle	-			-
Kemp's Ridley Turtle	-			-
Leatherback Turtle	-			-
Loggerhead Turtle	-			-

Table 108. Processed Estimates for Exposure to Sonar and Other Active Acoustic Sources – Naval Surface Warfare Center, Panama City Division: Unmanned Underwater Vehicles Demonstration

Species	Permanent Threshold Shift (PTS)			
	Model-Estimated	Pre-Activity Avoidance Behavior	With Implementation of Mitigation	Avoidance of Repeated Exposures (FINAL PREDICTION)
Cetaceans				
Blue Whale	0		0	0
Fin Whale	1		1	0
Humpback Whale	0		0	0
North Atlantic Right Whale	0		0	0
Sei Whale	0		0	0
Sperm Whale	1		1	0
Pinnipeds				
Ringed Seal – Arctic DPS	0			0
Sea Turtles				
Hardshell Turtles	0			0

Hawksbill Turtle	**0**			**0**
Kemp's Ridley Turtle	**0**			**0**
Leatherback Turtle	**0**			**0**
Loggerhead Turtle	**1**			**0**

Table 109. Processed Estimates for Exposure to Sonar and Other Active Acoustic Sources– South Florida Ocean Measurement Facility: Unmanned Underwater Vehicles Demonstration

Species	Permanent Threshold Shift (PTS)			
	Model-Estimated	**Pre-Activity Avoidance Behavior**	**With Implementation of Mitigation**	**Avoidance of Repeated Exposures (FINAL PREDICTION)**
Cetaceans				
Blue Whale	**0**		**0**	**0**
Fin Whale	**0**		**0**	**0**
Humpback Whale	**0**		**0**	**0**
North Atlantic Right Whale	**0**		**0**	**0**
Sei Whale	**0**		**0**	**0**
Sperm Whale	**1**		**1**	**0**
Pinnipeds				
Ringed Seal – Arctic DPS	**0**			**0**
Sea Turtles				
Hardshell Turtles	**0**			**0**
Hawksbill Turtle	**0**			**0**
Kemp's Ridley Turtle	**0**			**0**
Leatherback Turtle	**0**			**0**
Loggerhead Turtle	**0**			**0**

Table 110. Processed Estimates for Exposure to Sonar and Other Active Acoustic Sources– Naval Undersea Warfare Center Division, Newport Testing Range: Unmanned Underwater Vehicles Demonstration

Species	Permanent Threshold Shift (PTS)			
	Model-Estimated	**Pre-Activity Avoidance Behavior**	**With Implementation of Mitigation**	**Avoidance of Repeated Exposures (FINAL PREDICTION)**
Cetaceans				
Blue Whale	**0**		**0**	**0**
Fin Whale	**1**		**1**	**0**
Humpback Whale	**0**		**0**	**0**
North Atlantic Right Whale	**1**		**1**	**0**
Sei Whale	**0**		**0**	**0**
Sperm Whale	**0**		**0**	**0**
Pinnipeds				
Ringed Seal – Arctic DPS	**0**			**0**

Sea Turtles				
Hardshell Turtles	**0**			**0**
Hawksbill Turtle	**0**			**0**
Kemp's Ridley Turtle	**0**			**0**
Leatherback Turtle	**0**			**0**
Loggerhead Turtle	**1**			**0**

6.8.9 Response of Marine Mammals to Non-Impulsive Acoustic Stressors During Annual and Non-Annual Testing Activities

Our exposure analyses concluded that all of the ESA-listed whale species, the seal species, and the sea turtle species that occur within the action area would be exposed to active acoustic sources in the AFTT Study Area. Potential responses to that exposure, based on scientific literature, the Navy's assessment, and NMFS Permits Divisions analysis are described below, followed by the likely responses of ESA-listed species to those exposures to acoustic sources.

The information that follows is presented as if endangered or threatened marine animals that occur in the AFTT Study Area would be exposed to high, mid and low-frequency active sonar or sound pressure waves associated with underwater detonations when, in fact, any individuals that occur in the area of a training or testing event would be exposed to multiple potential stressors and would be responding to a wide array of cues from their environment including natural cues from other members of their social group, from predators, and other living organisms. However, the information that is available generally focuses on the physical, physiological, and behavioral responses of marine mammals to one or two stressors or environmental cues rather than the suite of anthropogenic and natural stressors that most free-ranging animals must contend with in their daily existence. We present the information from studies that investigated the responses of animals to one or two stressors, but we remain aware that we might observe very different results if we presented those same animals with the suite of stressors and cues they would encounter in the wild.

Table 111. Navy Predicted Impacts per Year from Annually-Recurring Sonar and Other Active Acoustic Testing Activities

Mysticetes	Behavioral Reaction	TTS	PTS
Blue Whale	6	10	0
Fin Whale	282	263	0
Humpback Whale	100	94	0
North Atlantic Right Whale	66	11	0
Sei Whale	316	439	0
Odontocetes – Sperm Whales			
Sperm Whale	1,101	584	0
Phocid Seals			
Ringed Seal – Arctic DPS	355	4	0

Table 112. Predicted for Non-annual Sonar and Other Active Acoustic Source Testing Activities Involving Unmanned Underwater Vehicle Demonstrations Occurring Once per Five Year Period at Each Location: Naval Surface Warfare Center, Panama City Division (NSWC PCD), South Florida Ocean Measurement Facility (SFOMF), and Naval Undersea Warfare Center, Newport (NUWCDIVNPT)

Mysticetes	Behavioral Reaction	TTS	PTS
Blue Whale	0	2	0
Fin Whale	2	46	0
Humpback Whale	0	5	0
North Atlantic Right Whale	0	10	0
Sei Whale	1	33	0
Odontocetes – Sperm Whales			
Sperm Whale	1	82	0
Phocid Seals			
Ringed Seal – Arctic DPS	0	0	0

6.8.9.1 *Cetaceans*

Predicted impacts on mysticetes from annual testing activities from sonar and other active acoustic sources would occur in the Northeast Range Complexes and testing ranges due primarily to submarine sonar testing and maintenance, torpedo testing, and unmanned underwater vehicle testing. Predicted impacts on mysticetes would occur at Naval Surface Warfare Center, Panama City Division Testing Range; the GOMEX Range Complex; and the Key West Range Complex due primarily to anti-submarine warfare sonar testing, unmanned underwater vehicle testing, and mine detection classification testing. Predicted impacts from testing activities in the VACAPES and JAX Range Complexes are primarily due to unmanned underwater vehicle testing, torpedo testing, and submarine sonar testing.

Ranges to TTS for hull-mounted sonar (e.g., sonar bin MF1: SQS-53 anti-submarine warfare hull-mounted sonar) can be on the order of several kilometers, whereas some behavioral effects could take place at distances exceeding 100 km. Significant behavioral effects, however, are much more likely at higher received levels within a few kilometers of the sound source.

Many mysticetes may stop vocalizing, break off feeding dives, or ignore the acoustic stimulus, especially if it is more than a few kilometers away. Migrating mysticetes may divert around sound sources that are within their path.

Sperm whales (classified as mid-frequency cetaceans) may be exposed to sonar or other active acoustic stressors associated with training activities throughout the year. Sperm whales within the Study Area belong to one of three stocks: North Atlantic; Gulf of Mexico Oceanic; or Puerto Rico and U.S. Virgin Islands. Predicted effects on sperm whales within the Gulf of Mexico are presumed to primarily impact the Gulf of Mexico Oceanic stock, whereas the majority of impacts predicted offshore of the east coast would impact the North Atlantic stock.

Research and observations show that if sperm whales are exposed to sonar or other active acoustic sources, they may react in a number of ways depending on their experience with the sound source and what activity they are engaged in at the time of the acoustic exposure. Sperm whales have shown resilience to acoustic and human disturbance, although they may react to sound sources and activities within a few kilometers. Sperm whales that are exposed to activities that involve the use of sonar and other active acoustic sources may alert, ignore the stimulus, avoid the area by swimming away or diving, or display aggressive behavior. Long-term consequences for individuals would not be expected.

Animals that do experience TTS may have reduced ability to detect relevant sounds such as predators, prey, or social vocalizations until their hearing recovers. Recovery from a threshold shift (i.e., partial hearing loss) can take a few minutes to a few days depending on the severity of the initial shift. Threshold shifts do not necessarily affect all hearing frequencies equally, so some threshold shifts may not interfere with an animal hearing biologically relevant sounds. Considering these factors, and the low number of overall predicted impacts, long-term consequences for individuals.

6.8.9.2 ***Pinnipeds***

The acoustic analysis indicates that phocid seals could be exposed to sound that may result in PTS, TTS, and behavioral reactions during annual testing activities using sonar and other active acoustic sources. These impacts would happen almost entirely within the Northeast Range Complexes. Nonrecurring unmanned underwater vehicle demonstrations could expose animals to sound that may result in PTS, TTS, and behavioral reactions over the five-year period at Naval Undersea Warfare Center Division, Newport Testing Range.

Research and observations show that pinnipeds in the water are tolerant of anthropogenic noise and activity. If seals are exposed to sonar or other active acoustic sources, they may not react at all until the sound source is approaching within a few hundred meters and then may alert, ignore the stimulus, change their behaviors, or avoid the immediate area by swimming away or diving. Significant behavioral reactions would not be expected in most cases, and long-term consequences for individual seals or populations are unlikely.

Recovery from a threshold shift (i.e., partial hearing loss) can take a few minutes to a few days, depending on the severity of the initial shift. PTS would not fully recover. Threshold shifts do not necessarily affect all hearing frequencies equally, so some threshold shifts may not interfere with an animal hearing biologically relevant sounds. It is uncertain whether some permanent hearing loss over a part of a marine mammal's hearing range would have long-term consequences for that individual, although many mammals lose hearing ability as they age.

Research and observations show that pinnipeds in the water are tolerant of anthropogenic noise and activity. If seals are exposed to sonar or other active acoustic sources, they may react in various ways, depending on their experience with the sound source and what activity they are engaged in at the time of the acoustic exposure. Seals may not react at all until the sound source is approaching within a few hundred meters and then may alert, ignore the stimulus, change their behaviors, or avoid the immediate area by swimming away or diving. Significant behavioral reactions would not be expected in most cases, and long-term consequences for individual seals or populations are unlikely.

Recovery from a hearing threshold shift (i.e., partial hearing loss- TTS) can take a few minutes to a few days depending on the severity of the initial shift. More severe shifts may not fully recover and thus would be considered PTS. Threshold shifts do not necessarily affect all hearing frequencies equally, so some threshold shifts may not interfere with an animal hearing biologically relevant sounds. It is uncertain whether some permanent hearing loss over a part of a marine mammal's hearing range would have long-term consequences for that individual, although many mammals lose hearing ability as they age.

6.8.10 **Response of Sea Turtles to Non-Impulsive Sound Stressors During Testing Activities**

Testing activities would typically occur in all of the range complexes; at Naval Surface Warfare Center, Panama City Division Testing Range; South Florida Ocean Measurement Facility; and at Naval Undersea Warfare Center Division, Newport Testing Range. Although impacts could occur across all of the range complexes and testing ranges due to various types of testing involving active acoustic sources, the portion of total predicted impacts are greater for certain activities, either due to the types of sources or the hours of use. For annual testing, the following types of activities at the locations noted produce the majority of predicted impacts: anti-submarine warfare tracking test – Maritime Patrol Aircraft (in the Northeast, VACAPES, Navy Cherry Point, and JAX Range Complexes), special warfare (Key West Range Complex), unmanned underwater vehicle testing (Naval Surface Warfare Center, Panama City Division Testing Range), and semi-stationary equipment testing (Naval Undersea Warfare Center Division, Newport Testing Range). An unmanned underwater vehicle demonstration event would not occur annually but could occur once at Naval Surface Warfare Center, Panama City Division Testing Range and once at Naval Undersea Warfare Center Division, Newport Testing Range over a five-year period. Testing events using sonar and other active acoustic sources are often multiday events during which active sources are used intermittently; therefore, some animals may be exposed multiple times over the course of a few days.

Predicted impacts due to annual testing are concentrated in the Southeast U.S. Continental Shelf Large Marine Ecosystem and in the Gulf Stream Open Ocean Area. Smaller, but notable, portions of impacts are also predicted in the Northeast U.S. Continental Shelf, Caribbean Sea, and Gulf of Mexico Large Marine Ecosystems. While most testing using anti-submarine warfare sonar would occur beyond 12 nm from shore, other testing activities using active acoustic sources may occur closer to shore, specifically at Naval Surface Warfare Center, Panama City Division Testing Range and at Naval Undersea Warfare Center Division, Newport Testing Range. In addition, testing of sonar systems could occur at multiple pierside locations. The addition of an unmanned underwater vehicle demonstration in any given year could increase impacts on sea turtles in nearshore areas in the Gulf of Mexico and Northeast U.S. Continental Shelf Large Marine Ecosystems. Sea turtles in the Gulf Stream Open Ocean Area would typically be post-hatchlings, juveniles, or migrating adults, while sea turtles in the other Large Marine Ecosystems would typically be adults and juveniles.

Approximately 9,822 sea turtles are predicted to experience TTS from annual testing, which would result in short-term reduced perception of sound within a limited frequency range, lasting from minutes to days, depending on the exposure. An additional 2,360 sea turtles are predicted to experience TTS from non-annual testing. Cues preceding the commencement of the event (e.g., vessel presence and movement, aircraft overflight) may result in some animals departing the immediate area, even before active sound sources begin transmitting. Avoidance behavior could reduce the sound exposure level experienced by a sea turtle and therefore reduce the likelihood and degree of TTS predicted near sound sources. In addition, PTS and TTS threshold criteria for sea turtles are conservatively based on criteria developed for mid-frequency marine mammals. Therefore, actual TTS impacts are expected to be substantially less than the predicted quantities. No instances of PTS were modeled as a result of annual testing activities.

Sea turtles may exhibit short-term behavioral reactions, such as swimming away or diving to avoid the immediate area around a source, although studies examining sea turtle behavioral responses to sound have used impulsive sources, not non-impulsive sources. Pronounced reactions to acoustic stimuli could lead to a sea turtle expending energy and missing opportunities to forage or breed. In nesting season, near nesting beaches (in the Southeast U.S. Continental Shelf, Caribbean, and Gulf of Mexico Large Marine Ecosystems), behavioral disturbances may interfere with nesting beach approach. In most cases, acoustic exposures are intermittent, allowing time to recover from an incurred energetic cost, resulting in no long-term consequence.

Because model-predicted impacts are conservative and most impacts would be short-term, potential impacts are not expected to result in substantial changes to behavior, growth, survival, annual reproductive success, or lifetime reproductive success (fitness) to most individuals.

Table 113.Annual U.S. Navy Model-Predicted Impacts on Sea Turtles from Testing Activities Using Sonar and Other Non-Impulsive Acoustic Sources

Sea Turtle Species or Group	Predicted Impact	
	Temporary Threshold Shift	Permanent Threshold Shift
Hardshell Turtles[1]	4,021	0
Kemp's Ridley Turtle	213	0
Loggerhead Turtle	4,847	0
Leatherback Turtle	741	0

[1] The Hardshell Turtles category includes a combined density estimate for green, hawksbill, and all unidentified hardshell turtles. There is no separate density estimate for green or hawksbill sea turtles.

Within the Study Area, critical habitat has been designated in the marine environment for the following sea turtle species: green sea turtles (waters out to 3 nm around Culebra Island, Puerto Rico, due to their importance as developmental and foraging habitat, hawksbill sea turtles (waters out to 3 nm around Mona and Monito Islands, Puerto Rico, due to their importance as developmental and foraging habitat, and leatherback sea turtles (waters inclusive of the 100 fathom curve shoreward off Sand Point, St. Croix, United States Virgin Islands, for mating and migratory access of the turtles to and from the nesting beach. At the time of these critical habitat designations, no primary constituent elements were listed to define the critical habitat. Sonar and other active acoustic sources within the hearing range of sea turtles are not proposed for use in the nearshore waters in or near these critical habitats. Any use of these sources near these waters would not result in the destruction or impairment of the habitat to support the foraging and development of green and hawksbill turtles or mating and nesting activities for the leatherback sea turtle.

Table 114.Annual U.S. Navy Model-Predicted Impacts on Sea Turtles from Unmanned Underwater Vehicle Demonstration Testing Using Sonar Acoustic Sources (occurs once per five-year period at each location)

Sea Turtle Species or Group	NSWC Panama City		SFOMF		NUWC Newport	
	Temporary Threshold Shift	Permanent Threshold Shift	Temporary Threshold Shift	Permanent Threshold Shift	Temporary Threshold Shift	Permanent Threshold Shift
Hardshell Turtles[1]	20	0	921	0	3	0
Kemp's Ridley Turtle	0	0	65	0	0	0
Loggerhead Turtle	139	0	1,142	0	7	0
Leatherback Turtle	21	0	40	0	2	0

NSWC: Naval Surface Warfare Center, Panama City Division Testing Range; NUWC: Naval Undersea Warfare Center Division, Newport Testing Range; SFOMF: South Florida Ocean Measurement Facility Testing Range

[1] The Hardshell Turtles category includes a combined density estimate for green, hawksbill, and all unidentified hardshell turtles. There is no separate density estimate for green or hawksbill sea turtles.

6.9 Risk of Exposure to Impulsive Acoustic Sources

Impulsive sound sources are those that involve at-sea explosions. Airguns also produce impulsive sound characteristics. Explosives detonated underwater introduce loud, impulsive, broadband sounds into the marine environment. The shock wave and blast noise from explosions are of most concern to marine animals. Depending on the intensity of the shock wave and size and depth of the animal, an animal can be injured or killed. Further from the blast, an animal may suffer non-lethal physical effects. Outside of these zones of death and physical injuries, marine animals may experience hearing related effects with or without behavioral responses.

The detonation depth of an explosive is particularly important due to a propagation effect known as surface-image interference. For sources located near the sea surface, a distinct interference pattern arises from the coherent sum of the two paths that differ only by a single reflection from the pressure-release surface. As the source depth and/or the source frequency decreases, these two paths increasingly, destructively interfere with each other, reaching total cancellation at the surface (barring surface-reflection scattering loss).

6.9.1 Risk from Impulsive Acoustic from Explosives

Explosive detonations during training and testing activities are associated with high-explosive ordnance, including bombs, missiles, and naval gun shells; torpedoes, mines, demolition charges, and explosive sonobuoys. Most explosive detonations during training and testing involving the use of high-explosive ordnance, including bombs, missiles, and naval gun shells, would occur in the air or near the water’s surface. Explosives associated with torpedoes and explosive sonobuoys would occur in the water column; mines and demolition charges could occur near the surface, in the water column, or the ocean bottom. Most detonations would occur in waters greater than 200 ft. (61 m) in depth, and greater than 3 nm from shore, although mine warfare, demolition, and some testing detonations could occur in shallow water close to shore. Detonations associated with Anti-Submarine Warfare would typically occur in waters greater than 600 ft. (182.9 m) depth.

Table 115. Number and Location of Surface Explosions

Activity Area	Training	Testing
Up to 100 lb. NEW Charges		
VACAPES	4	0
Total	4	0
Up to 60 lb. NEW Charges		
VACAPES	144	0
Cherry Point	4	0
JAX	4	0
Key West	2	0
GOMEX	2	0
Total	156	0
Up to 20 lb. NEW Charges		
VACAPES (W-50)	0	0
VACAPES	112	0
Cherry Point (UNDET Area)	0	0
Cherry Point	2	0
JAX (UNDET Areas North and South)	0	0
JAX	4	0
Key West	2	0
GOMEX	2	0
Total	122	0
Up to 10 lb. NEW Charges		
VACAPES	4	0
Cherry Point	2	0
JAX	2	0
Key West	2	0
GOMEX	2	0
Total	12	0
Bombs		
VACAPES (Air-K)	0	0
VACAPES	64	0
Cherry Point	32	0
JAX	32	0
GOMEX (W-155 Hotbox)	0	0
GOMEX	4	0

Other AFTT Areas (SINKEX Box)	1	0
Total	133	0
Rockets		
Northeast	0	0
VACAPES	3,800	202
Cherry Point	0	0
JAX	3,800	202
Key West	0	0
GOMEX	380	0
Total	7,980	404
Missiles		
Northeast	0	8
VACAPES (W-386, W-72, R-6604)	0	0
VACAPES [W-386 (Air E, F, I, J, K), W-72A]	0	0
VACAPES	118	4
Cherry Point [W-122 (16/17, 18/19/20/21)]	0	0
Cherry Point	40	0
JAX (MLTR)	0	0
JAX	126	4
Gulf of Mexico	0	4
Other AFTT Areas (SINKEX Box)	11	0
Total	295	20
Large Caliber Projectiles		
VACAPES (5C/D, 7C/D, 8C/D, 1C1/2)	0	0
VACAPES	4,884	0
Cherry Point [W-122 (4/5, 13/14)]	0	0
Cherry Point	866	0
JAX (BB,CC)	0	0
JAX	3,348	0
NSWC PCD	0	50
GOMEX	284	0
Other AFTT Areas (SINKEX Box)	700	0
Other AFTT Areas	96	0
AFTT Study Area	0	4,900
Total	10,178	4,950
Medium Caliber Projectiles		
VACAPES	49,936	11,200
Cherry Point	21,226	200
JAX	46,120	11,200
GOMEX	6,352	0
Other AFTT Areas	320	0
AFTT Study Area	0	3,500
Total	**123,954**	**26,100**

Overall Total	**142,834**	**31,474**

Explosives in the water introduce loud, impulsive, broadband sounds into the marine environment. Three source parameters influence the effect of an explosive: (1) the weight of the explosive warhead, (2) the type of explosive material, and (3) the detonation depth. The net explosive weight, the explosive power of a charge expressed as the equivalent weight of TNT, accounts for the first two parameters. The properties of explosive detonations are discussed in the EIS/OEIS (cite).

In general, explosive events would consist of a single explosion or multiple explosions over a short period. During training and testing, all large, high-explosive bombs would be detonated near the surface over deep water. Bombs with high-explosive ordnance would be fused to detonate on contact with the water. Other detonations would occur near but above the surface upon impact with a target; these detonations are conservatively assumed to occur at a depth of 1 m (3.3 ft.) for purposes of analysis. Detonations of projectiles during anti-air warfare would occur far above the water surface.

Table 116.Number and Location of Underwater Explosions

Activity Area	Training	Testing
Torpedoes		
Other AFTT Areas (SINKEX Box)	1	0
AFTT Study Area	0	8
Total	1	8
Sonobuoys		
Northeast	170	514
VACAPES	443	950
Cherry Point	183	204
JAX	1,113	244
Key West	0	1512
GOMEX	0	204
Gulf of Mexico	0	0
Other AFTT Areas	0	368
Total	1908	3996
Anti-Swimmer Grenades		
Northeast	52	0
VACAPES	74	0
Cherry Point	28	0
JAX (Charleston OPAREA UNDET Boxes North and	0	0
JAX	24	0
GOMEX (CC UNDET Box E3)	0	0
GOMEX	28	0
Total	206	0
Line Charges		

NSWC PCD	0	4
Total	0	4
LCS/DDG Ship Shock Charges		
VACAPES or JAX	0	12
Total	0	12
Aircraft Carrier Ship Shock Charges		
VACAPES or JAX	0	4
Total	0	4
Up to 650 lb. NEW Charges		
VACAPES	0	6
NSWC PCD	0	16
Total	0	22
Up to 100 lb. NEW Charges		
VACAPES	4	0
Gulf of Mexico	0	7
Total	4	7
Up to 75 lb. NEW Charges		
NSWC PCD	0	0
Total	0	0
Up to 60 lb. NEW Charges		
VACAPES (Little Creek)	6	0
VACAPES	144	0
Cherry Point	4	0
JAX	4	0
Key West	2	0
GOMEX	2	0
Total	162	0
Up to 20 lb. NEW Charges		
Northeast	1	0
VACAPES (W-50)	0	0
VACAPES (Little Creek)	60	0
VACAPES	113	0
Cherry Point (Onslow Bay UNDET Area)	0	0
Cherry Point	3	0
JAX (Charleston OPAREA UNDET Boxes North and	0	0
JAX	5	0
Key West	2	0
NSWC PCD	0	4
GOMEX	3	0
Total	186	4
Up to 10 lb. NEW Charges		
VACAPES	4	0
Cherry Point	2	0

JAX	2	20
Key West	2	0
NSWC PCD	0	0
GOMEX	2	20
Gulf of Mexico	0	0
Total	12	40
Up to 5 lb. NEW Charges		
VACAPES (W-50)	0	0
VACAPES (W-50, W-72)	0	0
VACAPES (Little Creek)	12	0
VACAPES	60	145
JAX	0	32
NSWC PCD	0	171
GOMEX	20	0
Gulf of Mexico	0	14
Total	92	362
Up to 0.25 lb. NEW Charges		
VACAPES (Little Creek)	1,440	0
Total	**1440**	**0**
Overall Total	**4011**	**4459**

Since most explosive sources used in military activities are munitions that detonate essentially upon impact, the effective source depths are quite shallow and, therefore, the surface-image interference effect can be pronounced. This effect would reduce peak pressures and potential impacts near the water surface.

Noise associated with weapons firing and the impact of non-explosive practice munitions could happen at any location within the Study Area but generally would occur at locations greater than 12 nm from shore for safety reasons. These training and testing events would occur in areas of the east coast training or testing ranges designated for anti-surface warfare and similar activities during ship transits between ranges. Testing activities involving weapons firing noise would be those events involved with testing weapons and launch systems. These activities would also take place throughout the Study Area primarily in the same locations as the training events occur.

The firing of a weapon may have several components of associated noise. Firing of guns could include sound generated by firing the gun (muzzle blast), vibration from the blast propagating through a ship's hull, and sonic booms generated by the projectile flying through the air. Missiles and targets would produce noise during launch. In addition, the impact of non-explosive practice munitions at the water surface can introduce sound into the water.

6.9.2 Risk of Impulsive Acoustics from Swimmer Defense Airguns

Swimmer defense airguns would be used for pierside integrated swimmer defense testing at pierside locations at Little Creek, and Panama City and NUWC Newport testing ranges. Testing events using swimmer defense airguns involves a limited number of impulses from a small airgun in inland waters around Navy piers. Airguns would be fired a limited number of times (up to 100) during each activity at an irregular interval as required for the testing objectives. These areas adjacent to Navy pierside integrated swimmer defense testing are industrialized, and the waterways carry a high volume of vessel traffic in addition to Navy vessels using the pier.

Underwater impulses would be generated using small (approximately 60 cubic inch [in.3]) airgun, which are essentially a stainless steel tube charged with high-pressure air via a compressor. An impulsive sound is generated when the air is almost instantaneously released into the surrounding water, an effect similar to popping a balloon in air. Generated impulses would have short durations, typically a few hundred milliseconds. The root-mean-squared sound pressure level and sound exposure level at a distance 1 m from the airgun would be approximately 200–210 dB re 1 µPa and 185–195 dB re 1 µPa2-s, respectively. Swimmer defense airguns lack the strong shock wave and rapid pressure increase that would be expected from explosive detonations.

6.9.3 Exposure of Fish to Impulsive Acoustic Stressors from Training Activities

Explosions and other impulsive sound sources include explosions from underwater detonations and explosive munitions, swimmer defense airguns, and noise from weapons firing, launch, and impact with the water's surface. Potential acoustic effects to fish from impulsive sound sources may be considered in four categories: (1) direct injury; (2) hearing loss; (3) auditory masking; and (4) physiological stress and behavioral reactions.

Concern about potential fish mortality associated with the use of at-sea explosives led military researchers to develop mathematical and computer models that predict safe ranges for fish and other animals from explosions of various sizes (e.g., Goertner 1982; Goertner et al. 1994; Yelverton et al. 1975a). Young (1991) provides equations that allow estimation of the potential effect of underwater explosions on fish possessing swim bladders using a damage prediction method developed by Goertner (1982). Young's parameters include the size of the fish and its location relative to the explosive source, but are independent of environmental conditions (e.g., depth of fish and explosive shot frequency). An example of such model predictions is shown in Table 117, which lists estimated explosive-effects ranges using Young's (1991) method for fish possessing swim bladders exposed to explosions that would typically occur during training exercises. The 10 percent mortality range is the distance beyond which 90 percent of the fish present would be expected to survive. It is difficult to predict the range of more subtle effects causing injury but not mortality (Continental Shelf Associates Inc. 2004).

Table 117. Estimated Explosive Effects Ranges for Fish with Swim Bladders

Training Operation and Type of Ordnance	NEW (lb.)	Depth of Explosion (ft.)	10% Mortality Range (ft.)		
			1-oz. Fish	1-lb. Fish	30-lb. Fish
Mine Neutralization					
MK-103 Charge	0.002	10	40	28	18
AMNS Charge	3.24	20	366	255	164
20-lb. NEW UNDET Charge	20	30	666	464	299

Missile Exercise					
Hellfire	8	3.3	317	221	142
Maverick	100	3.3	643	449	288
Firing Exercise with IMPASS					
HE Naval Gun Shell, 5-inch	8	1	244	170	109
Bombing Exercise					
MK-20	109.7	3.3	660	460	296
MK-82	192.2	3.3	772	539	346
MK-83	415.8	3.3	959	668	430
MK-84	945	3.3	1,206	841	541

AMNS: airborne mine neutralization system; ft.: foot/feet; HE: high-explosive; IMPASS: integrated marine portable acoustic scoring system; NEW: net explosive weight; lb.: pound; oz.: ounce, UNDET: underwater detonation; %: percent

Fish not killed or driven from a location by an explosion might change their behavior, feeding pattern, or distribution. Changes in behavior of fish have been observed as a result of sound produced by explosives, with effect intensified in areas of hard substrate (Wright 1982). Stunning from pressure waves could also temporarily immobilize fish, making them more susceptible to predation.

The number of fish killed by an underwater explosion would depend on the population density in the vicinity of the blast, as well as factors discussed above such as net explosive weight, depth of the explosion, and fish size. For example, if an explosion occurred in the middle of a dense school of menhaden, herring, or other schooling fish, a large number of fish could be killed. Furthermore, the probability of this occurring is low based on the patchy distribution of dense schooling fish.

Noise under the muzzle blast of a 5-inch gun and directly under the flight path of the shell (assuming the shell is a few meters above the water's surface) would produce a peak sound pressure level of approximately 200 dB re 1 µPa near the surface of the water (1–2 m depth). Sound due to missile and target launches is typically at a maximum during initiation of the booster rocket and rapidly fades as the missile or target travels downrange. Many missiles and targets are launched from aircraft, which would produce minimal noise in the water due to the altitude of the aircraft at launch. Large-caliber non-explosive projectiles, non-explosive bombs, and intact missiles and targets could produce a large impulse upon impact with the water surface (McLennan 1997). These sounds from weapons firing launch, and impact noise would be transient and of short duration, lasting no more than a few seconds at any given location.

6.9.4 Exposures of Marine Mammals and Sea Turtles to Impulsive Acoustic Stressors from Annual Training Exercises

As described above, for this consultation, we considered exposure estimates from the Navy Acoustic Effects Model at several output points to estimate exposures of marine mammals and sea turtles. Exposure of fish to acoustic stressors was not modeled due to limited information on species distribution and densities in the action area. First, the total number of ESA-listed species (animats) that would be exposed to acoustic sources prior to the application of a dose-response curve or criteria. We term these the "unprocessed" estimates. A second set of exposure estimates of listed species were generated and "processed" using dose-response curves and criteria for temporary and permanent threshold shift developed by the Navy and NMFS' Permits Division. Lastly, the U.S. Navy applied a third step of incorporated species specific avoidance and mitigation to derive the Navy's final MMPA take request. The analysis presented in this opinion considers all three exposure estimates on an annual basis, cumulatively over the five year period, and cumulatively for the reasonably foreseeable future.

6.9.4.1 ***Unprocessed Estimates of Exposure to Impulsive Acoustics for Annual Training***

97.62% of the 157,163.95 exposures to impulsive sound stressors during annual training occur within the Jacksonville, Charleston Operating Areas, and VACAPES Range Complex. The table below provides the relative contribution of Unprocessed exposures by annual training exercise type. We note that an estimated 91% of exposures result from BOMBEX [A-S], COMPTUEX, FIREX, GUNEX [A-S], GUNEX [S-S] – Ship – Large Caliber, MISSILEX [A-S] and MISSILEX [A-S] – Rocket, and TRACKEX/TORPEX – MPA Sonobuoy exercises.

Table 118. Impulsive Sound Contribution by Annual Training Exercise in the AFTT Study Area

Annual Training Exercise	% Unprocessed Exposures by Exercise
BOMBEX (A-S)	**23.43%**
COMPTUEX	**5.04%**
FIREX	**7.02%**
Group Sail	2.30%
GUNEX [A-S] – Medium Caliber	**4.05%**
GUNEX [S-S] – Boat – Medium Caliber	0.05%
GUNEX [S-S] – Ship – Large Caliber	**5.02%**
GUNEX [S-S] - Ship – Medium Caliber	1.49%
JTFEX-SUSTAINEX/SUSTAINEX	0.45%
Maritime Security Operations – Anti-Swimmer Grenade	0.02%
Mine Neutralization – EOD	3.08%
Mine Neutralization – ROV	0.19%
MISSILEX [A-S]	**15.35%**
MISSILEX [A-S] - Rocket	**5.11%**
MISSILEX [S-S]	0.97%
Sinking Exercise	0.44%
TRACKEX/TORPEX – MPA Sonobuoy	**25.98%**

Relative to the total unprocessed exposures to impulsive sound stressors from annual training each year, the sections below summarizes the number of modeled exposures (animats) by species.

6.9.4.1.1 Blue Whale

The model estimates that blue whales will be exposed to explosions and other impulsive acoustic stressors associated with training exercises and testing activities throughout the year.

The NAEMO provided an unprocessed estimate of 44 blue whale exposure events annually to impulsive sounds associated with annual training at levels between 120 and 156 dB SPL and 14 exposure events annually at levels between 157 and 177 dB SPL. No exposures to impulsive sounds associated with annual training are expected above 177 dB SPL. Approximately 18 of these exposures will occur in JAXOACHOA and 23 in VACAPES, largely from MPA sonobuoy TRACKEX/TORPEX, BOMBEX [A-S], and FIREX.

6.9.4.1.2 Fin Whale

The model estimates that fin whales will be exposed to explosions and other impulsive acoustic stressors associated with training exercises and testing activities throughout the year.

The NAEMO provided an unprocessed estimate of 1,108 fin whale exposure events annually to impulsive sounds associated with annual training at levels between 120 and 156 dB SPL and 419 exposure events annually at levels between 157 and 198 dB SPL. No exposures to impulsive sounds associated with annual training are expected above 198 dB SPL. Approximately 935 of these exposures will occur in VACAPES, 207 in CPOA, and 187 in JAXOACHOA (Table 119).

Table 119. Activities that result in the highest percentages of fin whales unprocessed exposures to impulsive sounds associated with annual training acoustic sources in the Atlantic Fleet Training and Testing (AFTT) Study Area.

Species-largest activity contributors to exposure	Largest contributing OPAREAs/ranges		
	VACAPES	CPOA	JAXOACHOA
Fin whale exposures	**935**	**207**	**187**
BOMBEX [A-S]	370	144	11
GUNEX [S-S] - ship - large caliber	93	7	12
COMPTUEX			24
MISSILEX [A-S]	46		7
GUNEX [S-S] - ship - medium caliber	67		
GUNEX [A-S] - medium caliber	36		
FIREX	88	6	22
TRACKEX/TORPEX - MPA sonobuoy	165	32	
Mine neutralization - EOD	37		96

6.9.4.1.3 Humpback Whale

The model estimates that humpback whales will be exposed to explosions and other impulsive acoustic stressors associated with training exercises and testing activities throughout the year.

The NAEMO provided an unprocessed estimate of 365 humpback whale exposure events annually to impulsive sounds associated with annual training at levels between 120 and 156 dB SPL and 146 exposure events annually at levels between 157 and 199 dB SPL. No exposures to impulsive sounds associated with annual training are expected above 199 dB SPL. Approximately 149 of these exposures will occur in JAXOACHOA, 133 in VACAPES, and 95 in CPOA (Table 120).

Table 120. Activities that result in the highest percentages of humpback whales unprocessed exposures to impulsive sounds associated with annual training acoustic sources in the Atlantic Fleet Training and Testing (AFTT) Study Area.

Species-largest activity contributors to exposure	Largest contributing OPAREAs/ranges		
	JAXOACHOA	VACAPES	CPOA
Humpback whale exposures	**149**	**133**	**95**
BOMBEX [A-S]	14	66	68
COMPTUEX	19		
FIREX	13	34	
GUNEX [A-S] - rocket		20	
GUNEX [S-S] - ship - large caliber		12	
TRACKEX/TORPEX - MPA sonobuoy		34	12
MISSILEX [A-S]		21	
Mine neutralization - EOD		20	
Mine neutralization - ROV	78		

6.9.4.1.4 North Atlantic Right Whale

The model estimates that North Atlantic right whales will be exposed to explosions and other impulsive acoustic stressors associated with training exercises and testing activities throughout the year.

The NAEMO provided an unprocessed estimate of 16 North Atlantic right whale exposure events annually to impulsive sounds associated with annual training at levels between 120 and 156 dB SPL and 56 exposure events annually at levels between 157 and 192 dB SPL. No exposures to impulsive sounds associated with annual training are expected above 192 dB SPL. Approximately 18 of these exposures will occur in JAXOACHOA (seven from FIREX and most other from GUNNEX actions) and 51 in VACAPES (19 from EOD mine neutralization, 12 from BOMBEX [A-S], and seven from GUNEX [A-S] - rocket).

6.9.4.1.5 Sei Whale

The model estimates that sei whales will be exposed to explosions and other impulsive acoustic stressors associated with training exercises and testing activities throughout the year.

The NAEMO provided an unprocessed estimate of 2,135 sei whale exposure events annually to impulsive sounds associated with annual training at levels between 120 and 156 dB SPL and 500 exposure events annually at levels between 157 and 197 dB SPL. No exposures to impulsive sounds associated with annual training are expected above 197 dB SPL. Approximately 1,134 of these exposures will occur in VACAPES, 619 in JAXOACHOA, 511 in CPOA, 124 in NBOA, and 112 in GOMEX (Table 121).

Table 121. Activities that result in the highest percentages of sei whales unprocessed exposures to impulsive sounds associated with annual training acoustic sources in the Atlantic Fleet Training and Testing (AFTT) Study Area.

Species-largest activity contributors to exposure	Largest contributing OPAREAs/ranges				
	VACAPES	**JAXOACHOA**	**CPOA**	**NBOA**	**GOMEX**
Sei whale exposures	**1,134**	**619**	**511**	**124**	**112**
BOMBEX [A-S]	425		397		20
COMPTUEX		74			32
FIREX	114				
GUNEX [S-S] - ship - large caliber					43
GUNEX [A-S] - rocket	116				
GUNEX [A-S] - medium caliber	61				
TRACKEX/TORPEX - MPA sonobuoy	244	427	67	124	

6.9.4.1.6 Sperm Whale

The model estimates that sperm whales will be exposed to explosions and other impulsive acoustic stressors associated with training exercises and testing activities throughout the year.

The NAEMO provided an unprocessed estimate of 7,770 sperm whale exposure events annually to impulsive sounds associated with annual training at levels between 120 and 156 dB SPL and 3,480 exposure events annually at levels between 157 and 212 dB SPL. No exposures to impulsive sounds associated with annual training are expected above 212 dB SPL. Approximately 7,894 of these exposures will occur in VACAPES, 1,188 in JAXOACHA, and 808 in CPOA (Table 122).

Table 122. Activities that result in the highest percentages of sperm whales unprocessed exposures to impulsive sounds associated with annual training acoustic sources in the Atlantic Fleet Training and Testing (AFTT) Study Area.

Species-largest activity contributors to exposure	Largest contributing OPAREAs/ranges		
	VACAPES	**JAXOACHOA**	**CPOA**
Sperm whale exposures	**7,894**	**1,188**	**808**
BOMBEX [A-S]	1,829		624
COMPTUEX		126	
FIREX	1,227		
GUNEX [S-S] - ship - medium caliber	2,123		
GUNEX [A-S] - rocket	505		
GUNEX [S-S] – ship – large calber	753		
TRACKEX/TORPEX - MPA sonobuoy	1,012	857	111

6.9.4.1.7 Ringed Seal – Arctic DPS

The model estimates that ringed seals will be exposed to explosions and other impulsive acoustic stressors associated with training exercises and testing activities throughout the year.

The NAEMO provided an unprocessed estimate of 282 ringed seal exposure events annually to impulsive sounds associated with annual training at levels between 120 and 156 dB SPL and 223 exposure events annually at levels between 157 and 200 dB SPL. No exposures to impulsive sounds associated with annual training are expected above 200 dB SPL. Almost all of these exposures will result from BOMBEX [A-S] in JAXOACHOA.

6.9.4.1.8 Hardshell Sea Turtles

The model estimates that hardshell sea turtles will be exposed to explosions and other impulsive acoustic stressors associated with training exercises and testing activities throughout the year.

The NAEMO provided an unprocessed estimate of 31,650 hardshell sea turtle exposure events annually to impulsive sounds associated with annual training at levels between 120 and 156 dB SPL and 15,512 exposure events annually at levels between 157 and 239 dB SPL. No exposures to impulsive sounds associated with annual training are expected above 239 dB SPL. Approximately 21,036 of these exposures will occur in VACAPES, 20,555 in JAXOACHOA, 4,195 in CPOA, and 884 in NBOA (Table 123).

Table 123. Activities that result in the highest percentages of hardshell sea turtles unprocessed exposures to impulsive sounds associated with annual training acoustic sources in the Atlantic Fleet Training and Testing (AFTT) Study Area.

Species-largest activity contributors to exposure	Largest contributing OPAREAs/ranges			
	VACAPES	JAXOACHOA	CPOA	NBOA
Hardshell sea turtle exposures	**21,036**	**20,555**	**4,195**	**884**
BOMBEX [A-S]	6,521	225	3,021	
COMPTUEX	122	2,965		
FIREX	1,786	1,272	106	
Group sail	304	778	177	
GUNEX [S-S] - ship - large caliber	1,156	866	157	
GUNEX [S-S] - ship - medium caliber	420	226		
GUNEX [A-S] - rocket	1,937	340		
GUNEX [A-S] - medium caliber	879	832		
JTFEX-SUSTAINEX/SUSTAINEX		171		
Mine neutralization - EOD	1,047			
MISSILEX [A-S]	4,595	819		
TRACKEX/TORPEX - MPA sonobuoy	2,103	12,028	558	884

6.9.4.1.9 Kemp's Ridley Sea Turtle

The model estimates that Kemp's ridley sea turtles will be exposed to explosions and other impulsive acoustic stressors associated with training exercises and testing activities throughout the year.

The NAEMO provided an unprocessed estimate of 4,043 Kemp's ridley sea turtle exposure events annually to impulsive sounds associated with annual training at levels between 120 and

156 dB SPL and 12,325 exposure events annually at levels between 157 and 239 dB SPL. No exposures to impulsive sounds associated with annual training are expected above 239 dB SPL. Approximately 13,549 of these exposures will occur in VACAPES and 2,422 in JAXOACHOA (Table 124).

Table 124. Activities that result in the highest percentages of Kemp's ridley sea turtles unprocessed exposures to impulsive sounds associated with annual training acoustic sources in the Atlantic Fleet Training and Testing (AFTT) Study Area.

Species-largest activity contributors to exposure	Largest contributing OPAREAs/ranges	
	VACAPES	JAXOACHOA
Kemp's ridley sea turtle exposures	**13,549**	**2,422**
BOMBEX [A-S]	3,017	1,425
COMPTUEX		46
FIREX	1,046	175
GUNEX [S-S] - ship - large caliber	463	116
GUNEX [A-S] - rocket	657	61
GUNEX [A-S] - medium caliber	278	122
MISSILEX [A-S]	7,537	260
TRACKEX/TORPEX - MPA sonobuoy	254	154

6.9.4.1.10 Leatherback Sea Turtle

The model estimates that leatherback sea turtles will be exposed to explosions and other impulsive acoustic stressors associated with training exercises and testing activities throughout the year.

The NAEMO provided an unprocessed estimate of 23,532 leatherback sea turtle exposure events annually to impulsive sounds associated with annual training at levels between 120 and 156 dB SPL and 8,862 exposure events annually at levels between 157 and 239 dB SPL. No exposures to impulsive sounds associated with annual training are expected above 239 dB SPL. Approximately 17,623 of these exposures will occur in JAXOACHOA, 9,641 in CPOA, and 4,302 in VACAPES (Table 125).

Table 125. Activities that result in the highest percentages of leatherback sea turtles unprocessed exposures to impulsive sounds associated with annual training acoustic sources in the Atlantic Fleet Training and Testing (AFTT) Study Area.

Species-largest activity contributors to exposure	Largest contributing OPAREAs/ranges		
	JAXOACHOA	CPOA	VACAPES
Leatherback sea turtle exposures	**17,623**	**9,641**	**4,302**
BOMBEX [A-S]	944	7,027	1,691
COMPTUEX	1,858	123	113
FIREX	2,084	253	278
MISSILEX [A-S]	1,453		191

GUNEX [S-S] - ship - large caliber	1,686	404	125
GUNEX [A-S] - rocket	400		490
GUNEX [A-S] - medium caliber	1,424		217
Mine neutralization - EOD			380
GUNEX [S-S] - ship - medium caliber	456	161	
TRACKEX/TORPEX - MPA sonobuoy	6,478	1,237	657

6.9.4.1.11 Loggerhead Sea Turtle

The model estimates that loggerhead sea turtles will be exposed to explosions and other impulsive acoustic stressors associated with training exercises and testing activities throughout the year.

The NAEMO provided an unprocessed estimate of 43,982 loggerhead sea turtle exposure events annually to impulsive sounds associated with annual training at levels between 120 and 156 dB SPL and 27,253 exposure events annually at levels between 157 and 239 dB SPL. No exposures to impulsive sounds associated with annual training are expected above 239 dB SPL. Approximately 35,416 of these exposures will occur in VACAPES, 26,649 in JAXOACHOA, 7,099 in CPOA, and 1,262 in (Table 126).

Table 126. Activities that result in the highest percentages of loggerhead sea turtles unprocessed exposures to impulsive sounds associated with annual training acoustic sources in the Atlantic Fleet Training and Testing (AFTT) Study Area.

Species-largest activity contributors to exposure	Largest contributing OPAREAs/ranges			
	VACAPES	**JAXOACHOA**	**CPOA**	**NBOA**
Loggerhead sea turtle exposures	**35,416**	**26,649**	**7,099**	**1,262**
BOMBEX [A-S]	10,951		5,132	
COMPTUEX		3,831	75	
FIREX	2,559	1,866	188	
Group sail	437	1,017	305	
MISSILEX [A-S]	8,229	1,337		
GUNEX [S-S] - ship - large caliber	1,486	1,355	282	
GUNEX [S-S] - ship - medium caliber	496	330		
GUNEX [A-S] - rocket	3,479	756		
GUNEX [A-S] - medium caliber	1,274	1,460		
Mine neutralization - EOD	2,953			
Mine neutralization - ROV	348			
JTFEX-SUSTAINEX/SUSTAINEX		249		
TRACKEX/TORPEX - MPA sonobuoy	9,939	14,371	937	1,261

6.9.4.1.12 Contribution of Exposures to Impulsive Acoustic Stressors by Training Activity

We also assessed the contribution of exposures by annual training activity. The following table summarizes these contributions.

Table 127. Percentage of unprocessed exposure estimate to impulsive sound sources from specific annual training exercises.

Species	Training activity						
	BOMBEX [A-S]	MPA sonobuoy TRACKEX/TORPEX	FIREX	GUNEX [A-S]-ship-large caliber	Mine neutralization - EOD	COMPTUEX	MISSILEX [A-S]
Blue whale	24	22	15	12	6	3	2
Fin whale	35	26	8	10	2	3	3
Humpback whale	29	12	10	5	4	5	4
North Atlantic right whale	20	1	15	5	27	2	6
Sei whale	33	33	6	7	1	5	1
Sperm whale	23	21	12	11	1	2	1
Ringed seal	100	--	--	--	--	--	--
Hardshell sea turtle	21	33	7	5	3	7	12
Kemp's ridley sea turtle	28	4	7	4	0	0	48
Leatherback sea turtle	30	27	8	7	1	7	5

6.9.4.2 ***Processed Estimates of Exposure to Impulsive Acoustic Stressors from Annual Training***

The following table provides the Model-Estimated exposures and further processed exposures considering Navy mitigation measures and natural avoidance behaviors of species to derive a final exposure estimates for levels that could result in PTS, Slight Lung Injury, and Mortality. Additionally, Behavioral and TTS-level impacts are not included, since Navy mitigation and avoidance behaviors are unpredictable at distances (range to effects) that behavioral impacts and TTS would be expected.

Table 128. Processed Exposure Estimates for Impulsive Acoustic Stressors (Explosives) from Annual Training

Species	PTS			Slight Lung Injury			Mortality		
	Model-Estimated	With Implementation of Mitigation	Avoidance of Repeated Exposures	Model-Estimated	Pre-Activity Avoidance	Implementation of Mitigation	Model-Estimated	Pre-Activity Avoidance	Implementation of Mitigation
Cetaceans									
Blue Whale	0	0	0	0		0	0		0
Fin Whale	0	0	0	0		0	0		0
Humpback Whale	0	0	0	0		0	0		0
North Atlantic Right Whale	0	0	0	0		0	0		0
Sei Whale	0	0	0	0		0	0		0
Sperm Whale	0	0	0	0		0	0		0
Pinnipeds									
Ringed Seal	0		0	0			0		
Sea Turtles									
Hardshell Sea Turtles	13		11	3			2		
Hawksbill Sea Turtle	6		5	2			1		
Kemp's Ridley Sea Turtle	3		2	1			1		
Leatherback Sea Turtle	19		14	2			1		
Loggerhead Sea Turtle	24		18	7			4		

6.9.5 Exposures to Impulsive Acoustic Stressors from Non-Annual Training Exercises

As described above, for this consultation, we considered exposure estimates from the Navy Acoustic Effects Model at several output points for marine mammals and sea turtles. Potential exposure of fish species to impulsive sound were not modeled. First, the total number of ESA-listed species (animats) that would be exposed to acoustic sources prior to the application of a dose-response curve or criteria. We term these the "unprocessed" estimates. A second set of exposure estimates of listed species were generated and "processed" using dose-response curves and criteria for temporary and permanent threshold shift developed by the Navy and NMFS' Permits Division. Lastly, the U.S. Navy applied a third step of incorporated species specific avoidance and mitigation to derive the Navy's final MMPA take request. The analysis presented in this opinion considers all three exposure estimates on an annual basis, cumulatively over the five year period, and cumulatively for the reasonably foreseeable future.

6.9.5.1 *Unprocessed Estimates of Exposure to Impulsive Acoustic Stressors from Non-Annual Training*

24.80% of the estimated 95.55 exposures from impulsive sound exposures occur within the Gulf of Mexico Range Complex; 39.09% occurs within the Jacksonville and Charleston Operating Areas and 36.12% occurs within the VACAPES Range Complex. The table below provides the relative contribution of impulsive sound. We note that an estimated 100% of exposures result from Civilian Port Defense training exercises.

Table 129. Impulsive Sound Contribution by Non-Annual Training Exercise in the AFTT Study Area

Annual Training Exercise	% Unprocessed Exposures by Exercise
Civilian Port Defense	**100.00%**

Relative to the total unprocessed exposures to impulsive sound stressors from non-annual training each year, the following sections summarize the number of modeled exposures (animats) by species.

6.9.5.1.1 Blue Whale

The NAEMO provided an unprocessed estimate of zero blue whale exposure events annually to impulsive sounds associated with non-annual training at any level above 120 dB SPL.

6.9.5.1.2 Fin Whale

The NAEMO provided an unprocessed estimate of one fin whale exposure event annually to impulsive sounds associated with non-annual testing due to civilian port defense in GOMEX or JAXOACHOA.

6.9.5.1.3 Humpback Whale

The NAEMO provided an unprocessed estimate of zero humpback whale exposure events annually to impulsive sounds associated with non-annual training at any level above 120 dB SPL.

6.9.5.1.4 North Atlantic Right Whale

The NAEMO provided an unprocessed estimate of zero North Atlantic right whale exposure events annually to impulsive sounds associated with non-annual training at any level above 120 dB SPL.

6.9.5.1.5 Sei Whale

The NAEMO provided an unprocessed estimate of zero sei whale exposure events annually to impulsive sounds associated with non-annual training at any level above 120 dB SPL.

6.9.5.1.6 Sperm Whale

The NAEMO provided an unprocessed estimate of one sperm whale exposure event annually to impulsive sounds associated with non-annual training at any level above 120 dB SPL in VACAPES due to Civilian Port Defense.

6.9.5.1.7 Ringed Seal – Arctic DPS

The NAEMO provided an unprocessed estimate of zero ringed seal exposure events annually to impulsive sounds associated with non-annual training at any level above 120 dB SPL.

6.9.5.1.8 Hardshell Sea Turtles

The NAEMO provided an unprocessed estimate of zero hardshell sea turtle exposure events annually to impulsive sounds associated with non-annual training at levels between 120 and 156 dB SPL and 20 exposure events annually at levels between 157 and 179 dB SPL. No exposures to impulsive sounds associated with annual testing are expected above 179 dB SPL. Approximately four of these exposures will occur in GOMEX, eight will be in JAXOACHOA, and eight will be in the VACAPES.

6.9.5.1.9 Kemp's Ridley Sea Turtle

The NAEMO provided an unprocessed estimate of zero Kemp's ridley sea turtle exposure events annually to impulsive sounds associated with non-annual training at levels between 120 and 156 dB SPL and four exposure events annually at levels between 157 and180 dB SPL. No exposures to impulsive sounds associated with annual testing are expected above 180 dB SPL. Approximately three of these exposures will occur in JAXOACHOA and one in VACAPES.

6.9.5.1.10 Leatherback Sea Turtle

The NAEMO provided an unprocessed estimate of zero leatherback sea turtle exposure events annually to impulsive sounds associated with non-annual training at levels between 120 and 156 dB SPL and 10 exposure events annually at levels between 157 and 192 dB SPL. No exposures to impulsive sounds associated with annual testing are expected above 192 dB SPL. Approximately six of these exposures will occur in GOMEX, two will be in JAXOACHOA, and three in VACAPES, all due to Civilian Port Defense.

6.9.5.1.11 Loggerhead Sea Turtle

The NAEMO provided an unprocessed estimate of one loggerhead sea turtle exposure events annually to impulsive sounds associated with non-annual training at levels between 120 and 156 dB SPL and 61 exposure events annually at levels between 157 and 197 dB SPL. No exposures to impulsive sounds associated with annual testing are expected above 197 dB SPL.

Approximately 14 of these exposures will occur in GOMEX, 24 will be in JAXOACHOA, and 23 in VACAPES, all due to Civilian Port Defense.

6.9.5.2 *Processed Estimates of Exposure to Impulsive Aoustic Stressors from Non-Annual Training*

The processed estimates for Civilian Port Defense Training Activities (Single Event) resulted in no exposures to any ESA species at a level that would result in PTS, Slight Lung Injury or Mortality.

6.9.6 Response of Marine Mammals to Impulsive Acoustic Stressors from Annual and Non-Annual Training

Predicted impacts on mysticetes from training activities from explosions are relatively low over a year of training activities. All mysticetes within the Study Area could be exposed to sound and energy from explosions. Impacts are predicted primarily within VACAPES, JAX, and Navy Cherry Point Range Complexes, in the Northeast U.S. Continental Shelf and Southeast U.S. Continental Shelf Large Marine Ecosystems, and the Gulf Stream Open Ocean Area.

6.9.6.1 *Blue Whale*

After considering unprocessed and processed NAEMO instances of impulsive acoustic source exposures of whales, we assessed the potential received levels that cause whales to respond with behaviors that NMFS would classify as harassment. Additionally we assessed potential instances where whales could accumulate energy sufficient to result in temporary shifts in hearing sensitivity and where individuals could accumulate energy sufficient to result in permanent shift in hearing sensitivity, experience GI tract or lung injury, or possible be killed.

The estimated number of blue whales that could experience behavioral responses due to impulsive acoustic sources during training exercises is zero, the animals that could be expected to experience temporary threshold shift increased to zero, and only no blue whales would be could be expected to experience permanent threshold shift.

Blue whales may be exposed to sound or energy from explosions associated with training activities throughout the year, although acoustic modeling predicts no impacts on blue whales. Although blue whales are present in the Study Area, it is unlikely that explosive stressors and this species would co-occur based on the expected locations of training, best available science regarding marine mammal, and the typical short duration of the activities. Even with use of conservative assumptions in the acoustic impacts modeling, criteria, and the quantitative analysis of acoustic impacts predicts that this species is unlikely to be affected by the use of explosives.

6.9.6.2 *Fin Whale*

After considering unprocessed and processed NAEMO instances of impulsive acoustic source exposures of fin whales, we assessed the potential received levels that cause whales to respond with behaviors that NMFS would classify as harassment. Additionally we assessed potential instances where fin whales could accumulate energy sufficient to result in temporary shifts in hearing sensitivity and where individuals could accumulate energy sufficient to result in permanent shift in hearing sensitivity, experience GI tract or lung injury, or possibly be killed.

Fin whales may be exposed to sound or energy from explosions associated with training activities throughout the year, The quantitative analysis of acoustic impacts predicts that this species is would potentially have one behavioral reaction and one instance of TTS from training activities.

6.9.6.3 ***Humpback Whale***

After considering unprocessed and processed NAEMO instances of impulsive acoustic source exposures of humpback whales, we assessed the potential received levels that cause whales to respond with behaviors that NMFS would classify as harassment. Additionally we assessed instances where humpback whales could accumulate energy sufficient to result in temporary shifts in hearing sensitivity and where individuals could accumulate energy sufficient to result in permanent shift in hearing sensitivity, experience GI tract or lung injury, or possibly be killed.

The processed NAEMO results for impulsive acoustic source generate zero instances of humpback whales exposed to received levels that cause them to respond with behaviors that NMFS would classify as harassment during training exercises. There will be one instance in which humpback whales could accumulate energy sufficient to result in temporary shifts in hearing sensitivity, and zero humpback whale could accumulate energy sufficient to result in permanent shift in hearing sensitivity during training exercises. No humpback whales would experience GI tract or lung injury, and no humpback whales would be killed during training exercises.

The estimated number of humpback whales that could experience behavioral responses due to impulsive acoustic sources during training exercises is zero, the animals that could be expected to experience temporary threshold shift remained zero, and no humpback whales would be could be expected to experience permanent threshold shift.

Humpback whales may be exposed to sound or energy from explosions associated with training activities throughout the year. The quantitative analysis of acoustic impacts predicts that this species is would potentially have one behavioral response and one instance of TTS from training activities.

6.9.6.4 ***North Atlantic Right Whale***

North Atlantic right whales may be exposed to sound or energy from explosions associated with training activities throughout the year. After considering unprocessed and processed NAEMO instances of impulsive acoustic source exposures of North Atlantic right whales, we assessed the potential received levels that cause whales to respond with behaviors that NMFS would classify as harassment. Additionally we assessed potential instances where North Altantic right whales could accumulate energy sufficient to result in temporary shifts in hearing sensitivity and where individuals could accumulate energy sufficient to result in permanent shift in hearing sensitivity, experience GI tract or lung injury, or possibly be killed.

The estimated number of North Atlantic right whales that could experience behavioral responses due to impulsive acoustic sources during training exercises is zero, the animals that could be expected to experience temporary threshold shift remained zero, and only one North Atlantic right whales would be expected to experience permanent threshold shift.

Training activities that use explosives, with the exception of training with explosive sonobuoys, are not conducted in the southeast North Atlantic right whale mitigation area. Training activities that use explosives would not occur in the northeast North Atlantic right whale mitigation area. The sound and energy from explosions associated with training activities under the No Action Alternative would not impact the assumed primary constituent elements of the southeast North Atlantic right whale critical habitat (i.e., water temperature and depth).

6.9.6.5 ***Sei Whale***

After considering unprocessed and processed NAEMO instances of impulsive acoustic source exposures of whales, we assessed the potential received levels that cause whales to respond with behaviors that NMFS would classify as harassment. Additionally we assessed potential instances where whales could accumulate energy sufficient to result in temporary shifts in hearing sensitivity and where individuals could accumulate energy sufficient to result in permanent shift in hearing sensitivity, experience GI tract or lung injury, or possibly be killed.

The final estimated number of sei whales that could experience behavioral responses due to impulsive acoustic sources during training exercises is zero, the animals that could be expected to experience temporary threshold shift is zero, and no sei whales would be expected to experience permanent threshold shift.

6.9.6.6 ***Sperm Whale***

Sperm whales may be exposed to sound or energy from explosions associated with training activities throughout the year. After considering unprocessed and processed NAEMO instances of impulsive acoustic source exposures of sperm whales, we assessed the potential received levels that cause whales to respond with behaviors that NMFS would classify as harassment. Additionally we assessed potential instances where sperm whales could accumulate energy sufficient to result in temporary shifts in hearing sensitivity and where individuals could accumulate energy sufficient to result in permanent shift in hearing sensitivity, experience GI tract or lung injury, or possibly be killed.

Impulsive acoustic sources are expected to generate zero instance of sperm whales exposed to received levels that cause them to respond with behaviors that NMFS would classify as harassment during training exercises. In addition, there will be another zero instance in which sperm whales could accumulate energy sufficient to result in temporary shifts in hearing sensitivity, and zero sperm whales could accumulate energy sufficient to result in permanent shift in hearing sensitivity during training exercises. No sperm whales would experience GI tract or lung injury, and no sperm whales would be killed during training exercises.

6.9.6.7 ***Ringed Seal – Arctic DPS***

Ringed seals may be exposed to sound or energy from explosions associated with training activities throughout the year. After considering unprocessed and processed NAEMO instances of impulsive acoustic source exposures of ringed seals, we assessed zero instances where the potential received levels that cause seals to respond with behaviors that NMFS would classify as harassment. Additionally we assessed zero instances where ringed seals could accumulate energy sufficient to result in temporary shifts in hearing sensitivity and where individuals could accumulate energy sufficient to result in permanent shift in hearing sensitivity, experience GI tract or lung injury, or possibly be killed.

6.9.7 Response of Sea Turtles to Impulsive Acoustic Stressors from Annual and Non-Annual Training

Exposures that result in injuries such as nonlethal trauma and PTS may limit an animal's ability to find or obtain food, communicate with other animals, avoid predators, and interpret the environment around it. Impairment of these abilities can decrease an individual's chance of survival or impact its ability to successfully reproduce. Mortality of an animal will remove the animal entirely from the population as well as eliminate its future reproductive potential.

There is some limited information on sea turtle behavioral responses to impulsive noise from airgun studies that can be used as a surrogate for explosive impact analysis. Any behavioral response to a single detonation would likely be a short-term startle response, if the animal responds at all. Multiple detonations over a short period may cause an animal to exhibit other behavioral reactions, such as interruption of feeding or avoiding the area.

The average ranges to impacts from explosions of different charge weights for each of the specific criteria (onset mortality, onset slight lung injury, onset slight gastrointestinal tract injury, PTS, and TTS). Sea turtles within the ranges to effects are predicted by the model to receive the associated impact. Information regarding the ranges to impacts is important not only for predicting acoustic impacts but also for verifying the accuracy of model results against real-world situations and determining adequate mitigation ranges to avoid higher level impacts, especially physiological impacts on sea turtles. Because propagation of the acoustic waves is affected by environmental factors at different locations and because some criteria are partially based on sea turtle mass, the range of impacts for particular criteria will vary.

Based on the estimate of sound exposure level that could induce a sea turtle to exhibit avoidance behavior when exposed to repeated impulsive, the distance from an explosion at which a sea turtle may behaviorally react (e.g., avoid by moving farther away) can be estimated. If exposed to a single impulsive sound, a sea turtle is assumed to exhibit a brief startle reaction that would likely be biologically insignificant.

6.9.8 Response of Fish to Impulsive Acoustic Stressors from Annual and Non-Annual Training

Explosions and other impulsive sound sources include explosions from underwater detonations and explosive munitions, swimmer defense airguns, noise from weapons firing, launch, and impact with the water's surface. Potential acoustic effects to fish from impulsive sound sources may be considered in four categories (1) direct injury; (2) hearing loss; (3) auditory masking; and (4) physiological stress and behavioral reactions.

6.9.8.1 *Smalltooth Sawfish*

While unlikely, due to their preference for shallow, nearshore habitats, smalltooth sawfish may occur in areas that coincide with training activities involving explosives, such as the JAX Range Complexes and the Panama City OPAREA. Encounters may result in behavior responses, hearing loss, physical injury, or death to fish near the activity.

Smalltooth sawfish could be exposed to training activities that produce in-water noise from weapons firing, launch, and non-explosive practice munitions impact with the water's surface. These encounters were they to occur, have the potential to expose smalltooth sawfish to noise, potentially resulting in short-term behavioral responses. Behavioral reactions would likely be short term (minutes) and substantive costs or long-term consequences for individuals would be expected. As such responses rising to the level of take are not expected.

The Key West Range Complex does not overlap with critical habitat areas; the northeastern boundary (W-174G) of the Key West Range Complex is within approximately 9 nm [17 km] of critical habitat at its closest point. Therefore, proposed training activities are unlikely to take place within smalltooth sawfish critical habitat, although sound from activities involving impulsive sound sources that take place near the Key West Range Complex boundary may be present within the critical habitat. The primary constituent elements (i.e., red mangroves and shallow water less than 3 ft. [0.9 m] deep) would not be affected.

6.9.8.2 ***Gulf Sturgeon***

Gulf sturgeon, when not spawning in the rivers, are found in the Gulf of Mexico in nearshore and inshore waters. They typically range in distribution from Louisiana through the panhandle of Florida (U.S. Fish and Wildlife Service and National Marine Fisheries Service 2009).

Due to their preference for shallow, nearshore waters (less than 20 ft. [6 m]) (Fox et al. 2000a; Fox et al. 2002), it is unlikely that Gulf sturgeon would occur in areas that coincide with training activities involving explosives in the GOMEX Range Complex. Encounters, if they were to occur, may result in behavioral responses, hearing loss, physical injury, or death to fish near the activity.

There is a potential for Gulf sturgeon to encounter training activities that produce in-water noise from weapons firing, launch, and non-explosive practice munitions impact with the water's surface within the GOMEX Range Complex where these activities occur. Due to the short-term, transient nature of these activities, animals are unlikely to be exposed multiple times within a short period. Behavioral reactions would likely be short-term (minutes) and substantive costs or long-term consequences for individuals or populations would not be expected. In addition, due to the sturgeon’s preference for nearshore, shallow waters, it is unlikely these fish would occur in waters in which the training was occurring. Therefore, we do not anticipate exposure or response to impulsive acoustic stressors from training activities rising to the level of take.

Proposed training activities overlap designated critical habitat for Gulf sturgeon within one mile of the coastline in the eastern Gulf of Mexico as discussed in Section 3.9.2.7.1 (Status and Management). Most of the primary constituent elements are generally not applicable to the Study Area since they occur within the riverine habitat of the species. The use of explosive and other impulsive sources in Gulf sturgeon critical habitat are unlikely to interfere with the individuals’ safe and unobstructed passage between riverine, estuarine, and marine habitats. However, part of the primary constituent elements for Gulf sturgeon critical habitat includes abundant prey items (e.g., amphipods, lancelets, polychaetes, gastropods, ghost shrimp, isopods, molluscs, and crustaceans) within estuarine and marine habitats and substrates. It is possible that the use of explosive sound sources within the critical habitat may impact the abundance of prey items within the vicinity of the sound source. Therefore, explosive sound sources used in proposed training activities may affect Gulf sturgeon designated critical habitat.

6.9.8.3 *Atlantic Sturgeon*

Atlantic sturgeon, when not in the rivers during spawning season, inhabit estuarine and marine waters of the Atlantic coast out to a depth of 164 ft. (50 m) (Bain 1997). Atlantic sturgeon are found along nearly the entire east coast of the United States from the St. Croix River in Maine south to the St. Johns River in Florida.

Atlantic sturgeon may occur in areas that coincide with training activities involving explosives, particularly in the Northeast, VACAPES, Navy Cherry Point, and JAX Range Complexes. Atlantic sturgeon frequent the waters of the continental shelf and migrate up and down the coastline. Underwater explosions, particularly those associated with mine warfare training that occur in shallow water areas close to shore, may coincide with areas sturgeon frequent. Encounters may result in behavioral responses, hearing loss, physical injury, or death to fish near the activity.

There is also a potential for Atlantic sturgeon to encounter training activities that produce in-water noise from weapons firing, launch, and non-explosive practice munitions impact with the water's surface within any of the Atlantic range complexes where these activities occur. Sturgeon exposed to noise from weapons firing, launch, and non-explosive practice munitions impact with the water's surface may exhibit brief behavioral reactions. However, due to the short-term, transient nature of these activities, animals are unlikely to be exposed multiple times within a short period. Behavioral reactions would likely be short-term (minutes) and substantive costs or long-term consequences for individuals or populations would not be expected. Therefore, we do not anticipate exposure or response to impulsive acoustic stressors from training activities rising to the level of take.

6.9.9 Exposure of Fish to Impulsive Acoustic Stressors from Annual Testing

Testing activities that produce in-water noise from weapons firing, launch, and non-explosive practice munitions impact with the water's surface. Activities are spread throughout the Study Area but would be concentrated in the GOMEX and Northeast Range Complexes. These activities could take place within any large marine ecosystem or open ocean area, but would be concentrated within the Northeast U.S. Continental Shelf, and Gulf of Mexico Large Marine Ecosystems and the Gulf Stream Open Ocean Area.

Testing activities would include the use of swimmer defense airguns at Joint Expeditionary Base Little Creek, Virginia up to three times per year, and pierside at Newport, Rhode Island up to six times per year. Both of these areas are located within the inland waters of the Northeast U.S. Continental Shelf Large Marine Ecosystem. Stationary source testing at Naval Surface Warfare Center, Panama City Division Testing Range includes a limited amount of swimmer defense airgun use and could occur up to 11 times per year. This area is located in inland waters, within the Gulf of Mexico Large Marine Ecosystem.

Due to the lack of information on distribution and density of fish species throughout the action area and during annual testing activities, we are unable to estimate the amount or extent of exposures from impulsive acoustic stressors.

6.9.10 Exposures of Marine Mammals and Sea Turtles to Impulsive Acoustic Stressors from Annual Testing Activities

For this consultation, we considered exposure estimates from the Navy Acoustic Effects Model at several output points. First, the total number of ESA-listed species (animats) that would be exposed to acoustic sources prior to the application of a dose-response curve or criteria. We term these the "unprocessed" estimates. This estimate is the number of times individual animats or animals are likely to be exposed to the acoustic environment that is a result of training exercises and testing activities, regardless of whether they are "taken" as a result of that exposure. In most cases, the number of animals "taken" by an action would be a subset of the number of animals that are exposed to the action because (1) in some circumstances, animals might not respond to an exposure and (2) some responses may be adverse for an individual animal without constituting a form of "take" (for example, some physiological stress responses only have fitness consequences when they are sustained and would only constitute a "take" as a result of cumulative exposure).

A second set of exposure estimates of listed species were generated and "processed" using dose-response curves and criteria for temporary and permanent threshold shift developed by the Navy and NMFS Permits Division. Neither sets of exposure estimates, the unprocessed or processed, consider standard mitigation actions that the NMFS Permits Division would require under the MMPA rule to avoid marine mammals or that the Navy proposes for marine mammals, nor did the estimates consider any avoidance responses that might be taken by individual animals once they sense the presence of Navy vessels or aircraft.

Lastly, the U.S. Navy applied a third step of incorporated species specific avoidance and mitigation to derive the Navy's final MMPA take request. The analysis presented in this opinion considers all three exposure estimates on an annual basis, cumulatively over the five year period, and cumulatively for the reasonably foreseeable future.

6.9.10.1 *Unprocessed Estimates of Exposure to Impulsive Sound for Annual Testing*

90% of the 91,073.4 exposures to impulsive sound stressors during annual testing occur within the Jacksonville/Charleston Operating Areas, Key West and VACAPES Range Complex. The table below provides the relative contribution of Unprocessed exposures by annual training exercise type. We note that an estimated 90% of exposures result from Sonobuoy Lot Acceptance Testing (52%), ASW Tracking Test –MPA (33%) and Airborne Projectile-Based Mine Clearance System actitivies.

Table 130. Impulsive Sound Contribution by Annual Testing Activities in the AFTT Study Area

Annual Testing Activity	% Unprocessed Exposures byActivity
Gunnert testing	1.71%
Missile testing	2.93%
Airborne Mine Neutralization Systems	1.23%

Airborne Projectile-Based Mine Clearance System	**4.73%**
Airborne Towed Mine Sweeping Test	0.13%
ASW Tracking Test - MPA	**33.33%**
At-Sea Explosives Testing	0.02%
MCM Mission Package Testing	0.12%
Mine Countermeasure/Neutralization Testing	0.05%
NSWC: Mine Countermeasure/Neutralization Testing	0.05%
NSWC: Ordnance Testing	0.06%
Rocket Test	0.47%
Sonobuoy Lot Acceptance Testing	**52.02%**
SUW Mission Package Testing	0.75%
Torpedo (Explosive) Testing	2.40%
NSWC: Stationary Source Testing	0.01%
NUWC: Pierside Integrated Swimmer Defense	0.01%

Relative to the total unprocessed exposures to impulsive sound stressors from annual testing activities each year, the sections below summarize the number of modeled exposures (animats) by species.

6.9.10.1.1 Blue Whale

The NAEMO provided an unprocessed estimate of 25 blue whale exposure events annually to impulsive sounds associated with annual testing at levels between 120 and 156 dB SPL and 20 exposure events annually at levels between 157 and 193 dB SPL. No exposures to impulsive sounds associated with annual testing are expected above 193 dB SPL. Approximately 17 of these exposures will occur in VACAPES mostly from helo ASW tracking tests and 10 will be in the Key West OPAREA due to sonobuoy lot acceptance testing.

6.9.10.1.2 Fin Whale

The NAEMO provided an unprocessed estimate of 338 fin whale exposure events annually to impulsive sounds associated with annual testing at levels between 120 and 156 dB SPL and 330 exposure events annually at levels between 157 and 196 dB SPL. No exposures to impulsive sounds associated with annual testing are expected above 196 dB SPL. Approximately 339 of these exposures will occur in VACAPES, 128 in NBOA, 62 in CPOA, 29 will be in STL and BRC, respectively, and 24 will be in the NTL (Table 131).

Table 131. Activities that result in the highest percentages of fin whales unprocessed exposures to impulsive sounds associated with annual testing acoustic sources in the Atlantic Fleet Training and Testing (AFTT) Study Area.

Species-largest activity contributors to exposure	**Largest contributing OPAREAs/ranges**					
	VACAPES	**NBOA**	**CPOA**	**STL**	**BRC**	**NTL**
Fin whale exposures	**339**	**128**	**62**	**29**	**29**	**24**
ASW tracking test - MPA	126	93	62	29	28	24
ASW tracking test - helo	161	22				

6.9.10.1.3 Humpback Whale

The NAEMO provided an unprocessed estimate of 117 humpback whale exposure events annually to impulsive sounds associated with annual testing at levels between 120 and 156 dB SPL and 114 exposure events annually at levels between 157 and 193 dB SPL. No exposures to impulsive sounds associated with annual testing are expected above 193 dB SPL. Approximately 111 of these exposures will occur in VACAPES, 32 in JAXOACHOA, 23 will be in CPOA, 22 in NBOA, and 20 in the NTL (Table 132).

Table 132. Activities that result in the highest percentages of humpback whales unprocessed exposures to impulsive sounds associated with annual testing acoustic sources in the Atlantic Fleet Training and Testing (AFTT) Study Area.

Species-largest activity contributors to exposure	Largest contributing OPAREAs/ranges				
	VACAPES	**JAXOACHOA**	**CPOA**	**NBOA**	**NTL**
Humpback whale exposures	**111**	**32**	**23**	**22**	**20**
ASW tracking test - MPA	42	25	23	13	20
ASW tracking test - Helo	52			5	

6.9.10.1.4 North Atlantic Right Whale

The NAEMO provided an unprocessed estimate of four North Atlantic right whale exposure events annually to impulsive sounds associated with annual testing at levels between 120 and 156 dB SPL and 21 exposure events annually at levels between 157 and 192 dB SPL. No exposures to impulsive sounds associated with annual testing are expected above 192 dB SPL. Approximately 15 of these exposures will occur in the BRC, five will be in the Panama City testing range from airborne mine neutralization systems, and four will be in VACAPES from [A-S] gunnery testing, missile testing, airborne projectile-based mine clearance system, and airborne mine neutralization systems.

6.9.10.1.5 Sei Whale

The NAEMO provided an unprocessed estimate of 888 sei whale exposure events annually to impulsive sounds associated with annual testing at levels between 120 and 156 dB SPL and 751 exposure events annually at levels between 157 and 195 dB SPL. No exposures to impulsive sounds associated with annual testing are expected above 195 dB SPL. Approximately 695 of these exposures will occur in VACAPES, 165 in NBOA, 160 in STL, 147 in JAXOACHOA, 133 in NTL, 123 in Key West, 102 in GOMEX, and 96 will be in the CPOA (Table 133).

Table 133. Activities that result in the highest percentages of sei whales unprocessed exposures to impulsive sounds associated with annual testing acoustic sources in the Atlantic Fleet Training and Testing (AFTT) Study Area.

	Largest contributing OPAREAs/ranges							
Species-largest activity contributors to exposure	**VACAPES**	**NBOA**	**STL**	**JAXOACHOA**	**NTL**	**Key West**	**GOMEX**	**CPOA**
Sei whale exposures	**695**	**165**	**160**	**147**	**133**	**123**	**102**	**96**
ASW tracking test - MPA	288	91	160	110	133		72	96
ASW tracking test - Helo	344	45						

Explosive torpedo testing	33	29		25			27	
Sonobuoy lot acceptance testing						123		

6.9.10.1.6 Sperm Whale

The NAEMO provided an unprocessed estimate of 1,978 sperm whale exposure events annually to impulsive sounds associated with annual testing at levels between 120 and 156 dB SPL and 4,236 exposure events annually at levels between 157 and 202 dB SPL. No exposures to impulsive sounds associated with annual testing are expected above 202 dB SPL. Approximately 3,439 of these exposures will occur in VACAPES, 626 will be in Key West, 472 in NTL, 444 in STL, 442 in NBOA, 282 in GOMEX, and 171 in CPOA (Table 134).

Table 134. Activities that result in the highest percentages of sperm whales unprocessed exposures to impulsive sounds associated with annual testing acoustic sources in the Atlantic Fleet Training and Testing (AFTT) Study Area.

	Largest contributing OPAREAs/ranges							
Species-largest activity contributors to exposure	**VACAPES**	**Key West**	**STL**	**NTL**	**NBOA**	**JAXOACHOA**	**GOMEX**	**CPOA**
Sperm whale exposures	**3,439**	**626**	**444**	**472**	**442**	**302**	**282**	**171**
ASW tracking test - MPA	743		444	472	241	224	200	171
ASW tracking test - Helo	2,488				134			
Explosive torpedo testing	110					59	74	
Sonobuoy lot acceptance testing		626						

6.9.10.1.7 Ringed Seal – Arctic DPS

The NAEMO provided an unprocessed estimate of two ringed seal exposure events annually to impulsive sounds associated with annual testing at levels between 120 and 156 dB SPL and five exposure events annually at levels between 157 and 192 dB SPL. No exposures to impulsive sounds associated with annual testing are expected above 192 dB SPL. These would result entirely from MPA ASW track testing in the BRC.

6.9.10.1.8 Hardshell Sea Turtles

The NAEMO provided an unprocessed estimate of 32,872 hardshell sea turtle exposure events annually to impulsive sounds associated with annual testing at levels between 120 and 156 dB SPL and 10,221 exposure events annually at levels between 157 and 239 dB SPL. No exposures to impulsive sounds associated with annual testing are expected above 239 dB SPL. Approximately 26,796 of these exposures will occur in Key West, 8,305 will be in JAXOACHOA, 5,641 in VACAPES, and 1,027 will be in the CPOA (Table 135).

Table 135. Activities that result in the highest percentages of hardshell sea turtles unprocessed exposures to impulsive sounds associated with annual testing acoustic sources in the Atlantic Fleet Training and Testing (AFTT) Study Area.

Species-largest activity contributors to	**Largest contributing OPAREAs/ranges**

exposure	Key West	JAXOACHOA	VACAPES	NBOA	CPOA
Hardshell sea turtle exposures	**26,796**	**8,305**	**5,641**	**1,053**	**1,027**
ASW tracking test - MPA		7,778	3,007	665	1,025
Missile testing			490		
Airborne projectile-based mine clearance system			1,142		
Explosive torpedo testing			482	388	
Sonobuoy lot acceptance testing	26,784				

6.9.10.1.9 Kemp's Ridley Sea Turtle

The NAEMO provided an unprocessed estimate of 1,010 Kemp's ridley sea turtle exposure events annually to impulsive sounds associated with annual testing at levels between 120 and 156 dB SPL and 1,537 exposure events annually at levels between 157 and 216 dB SPL. No exposures to impulsive sounds associated with annual testing are expected above 216 dB SPL. Approximately 2,223 of these exposures will occur in VACAPES, 173 in JAXOACHOA, and 131 in NBOA (Table 136).

Table 136. Activities that result in the highest percentages of Kemp's ridley sea turtles unprocessed exposures to impulsive sounds associated with annual testing acoustic sources in the Atlantic Fleet Training and Testing (AFTT) Study Area.

Species-largest activity contributors to exposure	Largest contributing OPAREAs/ranges		
	VACAPES	JAXOACHOA	NBOA
Kemp's ridley sea turtle exposures	**2,223**	**173**	**131**
ASW tracking test - MPA	303	96	91
Explosive torpedo testing	52		40
Airborne projectile-based mine clearance system	1,127		
Gunnery testing	74	31	
Missile testing	492	22	
SUW mission package testing	136		

6.9.10.1.10Leatherback Sea Turtle

The NAEMO provided an unprocessed estimate of 4,353 leatherback sea turtle exposure events annually to impulsive sounds associated with annual testing at levels between 120 and 156 dB SPL and 2,540 exposure events annually at levels between 157 and 214 dB SPL. No exposures to impulsive sounds associated with annual testing are expected above 214 dB SPL. Approximately 2,271 of these exposures will occur in CPOA, 1,663 will be in JAXOACHOA, 1,527 in VACAPES, 782 in Key West, 339 in Panama City, and 223 in NBOA (Table 137).

Table 137. Activities that result in the highest percentages of leatherback sea turtles unprocessed exposures to impulsive sounds associated with annual testing acoustic sources in the Atlantic Fleet Training and Testing (AFTT) Study Area.

Species-largest activity contributors to	Largest contributing OPAREAs/ranges

exposure	CPOA	JAXOACHOA	VACAPES	Key West	Panama City	NBOA
Leatherback sea turtles exposures	**2,271**	**1,663**	**1,527**	**782**	**339**	**223**
ASW tracking test - MPA	2,269	608	1,236			174
Airborne projectile-based mine clearance system			107			
Gunenry testing		358	55			
Missile testing		490				
Airborne mine neutralization systems					245	
Explosive torpedo testing		109	63			48
Sonobuoy lot acceptance testing				782		

6.9.10.1.11Loggerhead Sea Turtle

The NAEMO provided an unprocessed estimate of 33,002 loggerhead sea turtle exposure events annually to impulsive sounds associated with annual testing at levels between 120 and 156 dB SPL and 11,638 exposure events annually at levels between 157 and 239 dB SPL. No exposures to impulsive sounds associated with annual testing are expected above 239 dB SPL. Approximately 22,515 of these exposures will occur in Key West, 10,097 in JAXOACHOA, 8,128 in VACAPES, 1,625 in CPOA, and 1,495 in NBOA (Table 138).

Table 138. Activities that result in the highest percentages of loggerhead sea turtles unprocessed exposures to impulsive sounds associated with annual testing acoustic sources in the Atlantic Fleet Training and Testing (AFTT) Study Area.

Species-largest activity contributors to exposure	Largest contributing OPAREAs/ranges				
	Key West	JAXOACHOA	VACAPES	CPOA	NBOA
Loggerhead sea turtle exposures	**22,515**	**10,097**	**8,128**	**1,625**	**1,495**
ASW tracking test - MPA		9,173	3,815	1,622	997
Explosive torpedo testing			625		498
Gunnery testing			362		
Missile testing			774		
Airborne projectile-based mine clearance system			1,949		
Sonobuoy lot acceptance testing	22,499				

6.9.10.2 *Sources of Impulsive Acoustic Exposures from Testing Activities*

The NAEMO model output (based on unprocessed estimates) indicates that six types of testing activities accounted for the majority of exposures to impulsive sound sources.

Table 139. Proportion of unprocessed exposure estimate to impulsive sound sources from annual testing activities.

Species	Testing activity

	MPA ASW tracking test	Sonobuoy lot acceptance testing	Helo ASW tracking test	Torpedo testing (explosive)	Airborne mine neutralization systems
Blue whale	38	23	28	9	--
Fin whale	58	--	28	5	2
Humpback whale	57	4	25	5	2
North Atlantic right whale	60	--	--	1	15
Sei whale	58	7	24	7	0
Sperm whale	40	10	42	5	0
Ringed seal	98	--	--	--	--
Hardshell sea turtle	29	62	--	2	0
Hawksbill sea turtle	30	62	--	2	1
Kemp's ridley sea turtle	20	0	20	4	0
Leatherback sea turtle	63	11	--	3	4
Loggerhead sea turtle	35	50	--	3	2

6.9.10.3 ***Processed Estimates of Exposure to Impulsive Sound for Annual Testing***

The following table provides the Model-Estimated exposures and further processed exposures considering Navy mitigation measures and natural avoidance behaviors of species to derive a final exposure estimates for levels that could result in PTS, Slight Lung Injury, and Mortality. Additionally, Behavioral and TTS-level impacts are not included, since Navy mitigation and avoidance behaviors are unpredictable at distances (range to effects) that behavioral impacts and TTS would be expected.

Table 140. Processed Estimates of Exposure for Impulsive Sound (Explosives) for Annual Testing Activities

Species	PTS			Slight Lung Injury			Mortality		
	Model-Estimated	Implementation of Mitigation	Avoidance of Repeated Exposures	Model-Estimated	Pre-Activity Avoidance	Implementation of Mitigation	Model-Estimated	Pre-Activity Avoidance	Implementation of Mitigation
Cetaceans									
Blue Whale	0	0	0	0		0	0		0
Fin Whale	0	0	0	0		0	0		0
Humpback Whale	0	0	0	0		0	0		0
North Atlantic Right Whale	0	0	0	0		0	0		0
Sei Whale	0	0	0	0		0	0		0
Sperm Whale	0	0	0	0		0	0		0
Pinnipeds									
Ringed Seal	0		0	0			0		
Sea Turtles									
Hardshell Sea Turtles	11		7	4			5		
Hawksbill Sea Turtle	5		3	2			2		
Kemp's Ridley Sea Turtle	1		0	0			2		
Leatherback Sea Turtle	3		2	1			0		
Loggerhead Sea Turtle	11		7	5			5		

6.9.11 Exposure of Fish to Impulsive Acoustic Stressors from Non-Annual Testing Activities

Testing activities would involve underwater detonations and explosive practice munitions. Testing activities involving explosions could be conducted throughout the Study Area but would be concentrated in the VACAPES Range Complex, followed by the JAX Range Complex. These events would be concentrated in the Northeast U.S. Continental Shelf, Southeast U.S. Continental Shelf Large Marine Ecosystems and the Gulf Stream Open Ocean Area. Testing activities using explosions do not normally occur within 3 nm of shore; the exception is the designated underwater detonation area near Naval Surface Warfare Center, Panama City Division Testing Range, which is located nearshore, partially within the surf zone.

Due to the lack of information on distribution and density of fish species throughout the action area and during annual testing activities, we are unable to estimate the amount or extent of exposures from impulsive acoustic stressors associated with non-annual testing activities.

6.9.12 Exposure of Marine Mammals and Sea Turtles to Impulsive Acoustic Stressors from Non-Annual Testing Activities

Testing activities would involve underwater detonations and explosive practice munitions. Testing activities involving explosions could be conducted throughout the Study Area but would be concentrated in the VACAPES Range Complex, followed by the JAX Range Complex. These events would be concentrated in the Northeast U.S. Continental Shelf, Southeast U.S. Continental Shelf Large Marine Ecosystems and the Gulf Stream Open Ocean Area. Testing activities using explosions do not normally occur within 3 nm of shore; the exception is the designated underwater detonation area near Naval Surface Warfare Center, Panama City Division Testing Range, which is located nearshore, partially within the surf zone.

6.9.12.1 *Unprocessed Estimates of Exposure to Impulsive Sound Stressors from Non-Annual Testing Activities*

0.01% of the estimated 216,890.87 exposures from impulsive sound exposures resulting from non-annual testing activities occur within the Cherry Point Operating Area; 61.49% occurs within the Jacksonville/Charleston Operating Areas and 38.50% occurs within the VACAPES Range Complex. The table below provides the relative contribution of impulsive sound. We note that an estimated 99% of exposures result from Shock Trial testing activities.

Table 141. Impulsive Sound Contribution by Non-Annual Testing Activities in the AFTT Study Area

Non-Annual Testing Activity	% Unprocessed Exposures by Exercise
Aircraft Carrier Sea Trial	0.16%
Shock Trials	**99.84%**

Relative to total unprocessed exposures to impulsive sound stressors from non-annual testing activities each year, the sections below summarize the number of modeled exposures (animats) by species.

6.9.12.1.1 Blue Whale

The NAEMO provided an unprocessed estimate of 19 blue whale exposure events annually to impulsive sounds associated with non-annual testing at levels between 120 and 156 dB SPL and 87 exposure events annually at levels between 157 and 194 dB SPL. No exposures to impulsive sounds associated with non-annual testing are expected above 194 dB SPL. Approximately 48 of these exposures will occur in JAXOACHOA and 57 in VACAPES, both from shock trials.

6.9.12.1.2 Fin Whale

The NAEMO provided an unprocessed estimate of 476 fin whale exposure events annually to impulsive sounds associated with non-annual testing at levels between 120 and 156 dB SPL and 1,157 exposure events annually at levels between 157 and 214 dB SPL. No exposures to impulsive sounds associated with non-annual testing are expected above 214 dB SPL. Approximately 91 of these exposures will occur in JAXOACHOA and 1,546 in VACAPES, both from shock trials.

6.9.12.1.3 Humpback Whale

The NAEMO provided an unprocessed estimate of 185 humpback whale exposure events annually to impulsive sounds associated with non-annual testing at levels between 120 and 156 dB SPL and 556 exposure events annually at levels between 157 and 210 dB SPL. No exposures to impulsive sounds associated with non-annual testing are expected above 210 dB SPL. Approximately 308 of these exposures will occur in JAXOACHOA and 426 in VACAPES, both from shock trials.

6.9.12.1.4 North Atlantic Right Whale

The NAEMO provided an unprocessed estimate of 27 North Atlantic right whale exposure events annually to impulsive sounds associated with non-annual testing at levels between 120 and 156 dB SPL and 20 exposure events annually at levels between 157 and 182 dB SPL. No exposures to impulsive sounds associated with non-annual testing are expected above 182 dB SPL. Approximately seven of these exposures will occur in JAXOACHOA and 19 in VACAPES, both entirely from shock trials.

6.9.12.1.5 Sei Whale

The NAEMO provided an unprocessed estimate of 800 sei whale exposure events annually to impulsive sounds associated with non-annual testing at levels between 120 and 156 dB SPL and 2,555 exposure events annually at levels between 157 and 239 dB SPL. No exposures to impulsive sounds associated with non-annual testing are expected above 239 dB SPL. Approximately 625 of these exposures will occur in JAXOACHOA and 2,687 in VACAPES, both from shock trials.

6.9.12.1.6 Sperm Whale

The NAEMO provided an unprocessed estimate of 2,726 sperm whale exposure events annually to impulsive sounds associated with non-annual testing at levels between 120 and 156 dB SPL and 19,771 exposure events annually at levels between 157 and 239 dB SPL. No exposures to impulsive sounds associated with non-annual testing are expected above 239 dB SPL.

Approximately 1,610 of these exposures will occur in JAXOACHOA and 20,576 in VACAPES, both from shock trials.

6.9.12.1.7 Ringed Seal – Arctic DPS

The NAEMO provided an unprocessed estimate of zero ringed seal exposure events annually to impulsive sounds associated with non-annual testing at any level above 120 dB SPL.

6.9.12.1.8 Hardshell Sea Turtles

The NAEMO provided an unprocessed estimate of 14,906 hardshell sea turtle exposure events annually to impulsive sounds associated with non-annual testing at levels between 120 and 156 dB SPL and 56,851 exposure events annually at levels between 157 and 239 dB SPL. No exposures to impulsive sounds associated with non-annual testing are expected above 239 dB SPL. Approximately 44,553 of these exposures will occur in JAXOACHOA and 26,876 in VACAPES, both almost entirely from shock trials.

6.9.12.1.9 Kemp's Ridley Sea Turtle

The NAEMO provided an unprocessed estimate of 3,897 Kemp's ridley sea turtle exposure events annually to impulsive sounds associated with non-annual testing at levels between 120 and 156 dB SPL and 6,211 exposure events annually at levels between 157 and 221 dB SPL. No exposures to impulsive sounds associated with non-annual testing are expected above 221 dB SPL. Approximately 8,374 of these exposures will occur in VACAPES and 1,714 in JAXOACHOA, both from shock trials.

6.9.12.1.10Leatherback Sea Turtle

The NAEMO provided an unprocessed estimate of 2,331 leatherback sea turtle exposure events annually to impulsive sounds associated with non-annual testing at levels between 120 and 156 dB SPL and 32,922 exposure events annually at levels between 157 and 239 dB SPL. No exposures to impulsive sounds associated with non-annual testing are expected above 239 dB SPL. Approximately 27,771 of these exposures will occur in JAXOACHOA and 4,790 in VACAPES, both almost entirely from shock trials.

6.9.12.1.11Loggerhead Sea Turtle

The NAEMO provided an unprocessed estimate of 27,008 loggerhead sea turtle exposure events annually to impulsive sounds associated with non-annual testing at levels between 120 and 156 dB SPL and 81,858 exposure events annually at levels between 157 and 239 dB SPL. No exposures to impulsive sounds associated with non-annual testing are expected above 239 dB SPL. Approximately 59,016 of these exposures will occur in JAXOACHOA and 49,312 in VACAPES, both almost entirely from shock trials.

6.9.12.2 *Processed Estimates of Exposure to Impulsive Sound for Non-Annual Testing*

Table 142 and Table 143 below provide the Model-Estimated exposures applying only the does response curve and further processed exposures considering Navy mitigation measures ansenatural avoidance behaviors of species to derive a final exposure estimates for levels that could result in PTS, Slight Lung Injury, and Mortality. Additionally, Behavioral and TTS-level impacts are not included, since Navy mitigation and avoidance behaviors are unpredictable at distances (range to effects) that behavioral impacts and TTS would be expected.

Table 142. Processed Estimates for Impulsive Sound (Explosives) – Aircraft Carrier Full Ship Shock Trial

Species	PTS			Slight Lung Injury			Mortality		
	Model-Estimated	Implementation of Mitigation	Avoidance of Repeated Exposures	Model-Estimated	Pre-Activity Avoidance	Implementation of Mitigation	Model-Estimated	Pre-Activity Avoidance	Implementation of Mitigation
Cetaceans									
Blue Whale	**0**	**0**		**0**		**0**	**0**		**0**
Fin Whale	**0**	**0**		**0**		**0**	**0**		**0**
Humpback Whale	**0**	**0**		**0**		**0**	**0**		**0**
North Atlantic Right Whale	**0**	**0**		**0**		**0**	**0**		**0**
Sei Whale	**0**	**0**		**1**		**0**	**1**		**0**
Sperm Whale	**1**	**0**		**4**		**3**	**4**		**2**
Pinnipeds									
[redacted]									
Sea Turtles									
Hardshell Sea Turtles	**2**			**215**			**40**		
Hawksbill Sea Turtle	**1**			**130**			**21**		
Kemp's Ridley Sea Turtle	**0**			**16**			**2**		
Leatherback Sea Turtle	**15**			**126**			**48**		
Loggerhead Sea Turtle	**5**			**531**			**67**		

Table 143. Processed Estimates for Impulsive Sound (Explosives) – DDG or Littoral Combat Ship Shock Trial (Single Full Ship Shock Trial)

Species	PTS			Slight Lung Injury			Mortality		
	Model-Estimated	Implementation of Mitigation	Avoidance of Repeated Exposures	Model-Estimated	Pre-Activity Avoidance	Implementation of Mitigation	Model-Estimated	Pre-Activity Avoidance	Implementation of Mitigation
Cetaceans									
Blue Whale	**0**	**0**		**0**		**0**	**0**		**0**
Fin Whale	**0**	**0**		**0**		**0**	**0**		**0**
Humpback Whale	**0**	**0**		**0**		**0**	**0**		**0**
North Atlantic Right Whale	**0**	**0**		**0**		**0**	**0**		**0**
Sei Whale	**0**	**0**		**0**		**0**	**0**		**0**
Sperm Whale	**0**	**0**		**2**		**1**	**1**		**0**
Pinnipeds									
[redacted]									
Sea Turtles									
Hardshell Sea Turtles	**1**			**23**			**4**		
Hawksbill Sea Turtle	**1**			**14**			**2**		
Kemp's Ridley Sea Turtle	**0**			**1**			**0**		
Leatherback Sea Turtle	**12**			**35**			**9**		
Loggerhead Sea Turtle	**3**			**42**			**9**		

6.9.13 Response of Marine Mammals to Impulsive Acoustic Stressors During Testing Activities

Testing activities would use underwater detonations and explosive munitions. Testing activities involving explosions could be conducted throughout the AFTT Study Area but would be concentrated in the VACAPES Range Complex, followed by the JAX and Key West Range Complexes. These events would be concentrated in the Northeast U.S. Continental Shelf, Southeast U.S. Continental Shelf, and Caribbean Sea Large Marine Ecosystems and the Gulf Stream Open Ocean Area. Testing activities using explosions do not normally occur within 3 nm of shore; the exception is the designated underwater detonation area near Naval Surface Warfare Center, Panama City Division Testing Range, which is nearshore, partially within the surf zone.

During an activity with a series of explosions (not concurrent multiple explosions), an animal is expected to exhibit an initial startle reaction to the first detonation followed by a behavioral response after multiple detonations. At close ranges and high sound levels approaching those that could cause PTS, avoidance of the area around the explosions is the assumed behavioral response for most cases. Animals not observed by Lookouts within the ranges to PTS at the time of the initial couple of explosions are assumed to experience PTS; however, animals that exhibit avoidance reactions beyond the initial range to PTS are assumed to move away from the expanding range to PTS effects with each additional explosion. Research has demonstrated that odontocetes have directional hearing, with best hearing sensitivity facing a sound source (Kastelein et al. 2005a; Mooney et al. 2008a; Popov and Supin 2009). Therefore, an odontocete avoiding a source would receive sounds along a less sensitive hearing axis, potentially reducing impacts. Because the Navy Acoustic Effects Model does not account for avoidance behavior, the model-estimated effects are based on unlikely behavior – that animals would remain in the vicinity of potentially injurious sound sources. Therefore, only the initial exposures resulting in model-estimated PTS are expected to actually occur. The remaining model-estimated PTS are considered to actually be TTS due to avoidance.

Predicted acoustic impacts on marine mammals from exposure to explosions during annually recurring testing activities are shown in Table 144 below.

Table 144. U.S. Navy Modeled, Annual Impacts from Impulsive Sound (Explosives) during Recurring Testing

Species	Behavioral Response	TTS	PTS	GI Tract Injury	Slight Lung Injury	1% Probability of Mortality
Mysticetes						
Blue Whale	0	0	0	0	0	0
Fin Whale	0	1	0	0	0	0
Humpback Whale	0	0	0	0	0	0
North Atlantic Right Whale	0	0	0	0	0	0
Sei Whale	0	1	0	0	0	0
Odontocetes						
Sperm Whale	1	0	0	0	0	0

Predicted acoustic impacts on marine mammals from exposure to explosions during non-annual testing activities are shown in Table 145 and Table 146 below.

Table 145. U.S. Navy Modeled Impacts from Impulsive Sound (Explosives) Aircraft Carrier Ship Shock Trials Occurring Once During the Five-Year Period (Up to 58,000 lb NEW)

Species	TTS	PTS	GI Tract Injury	Slight Lung Injury	1% Probability of Mortality
Mysticetes					
Blue Whale	0	0	0	0	0
Fin Whale	1	0	0	0	0
Humpback Whale	0	0	0	0	0
North Atlantic Right Whale	0	0	0	0	0
Sei Whale	1	0	0	1	0
Odontocetes					
Sperm Whale	3	0	0	2	1

Table 146. U.S. Navy Modeled Impacts for Impulsive Sound (Explosives) Guided Missile Destroyer and Littoral Combat Ship Shock Trials Occurring Three Times During a Five-Year Period (Up to 14,500 lb NEW)

Species	TTS	PTS	GI Tract Injury	Slight Lung Injury	1% Probability of Mortality
Mysticetes					
Blue Whale	0	0	0	0	0
Fin Whale	0	0	0	0	0
Humpback Whale	0	0	0	0	0
North Atlantic Right Whale	0	0	0	0	0
Sei Whale	0	0	0	0	0
Odontocetes					
Sperm Whale	1	0	0	0	0

The Navy Acoustic Effects Model does not account for several factors that must be considered in the overall explosive analysis. When there is uncertainty in model input values, a conservative approach is often chosen to assure that potential effects are not under-estimated. As a result, the Navy Acoustic Effects Model provides estimates that are conservative (over-estimate the likely impacts). The following is a list of several such factors that cause the model to overestimate potential effects:

- The onset mortality criterion is based on the impulse at which one percent of the animals receiving an injury would not recover, leading to mortality. Therefore, many animals that are predicted to suffer mortality in this analysis may actually recover from their injuries.
- Slight lung injury criteria is based on the impulse at which one percent of the animals exposed would incur a slight lung injury from which full recovery would be expected.

Therefore, many animals that are predicted to suffer slight lung injury in this analysis may actually not incur injuries.

- The metrics used for the threshold for slight lung injury and mortality (i.e., acoustic impulse) are based on the animal's mass. The smaller an animal, the more susceptible that individual is to these effects. In this analysis, all individuals of a given species are assigned the weight of that species newborn calf or pup weight. Since many individuals in a population are obviously larger than a newborn calf or pup of that species, this assumption causes the acoustic model to overestimate the number of animals that may suffer slight lung injury or mortality. The volumes of water in which the threshold for onset mortality may be exceeded are generally less than a fifth for an adult animal versus a calf.
- Many explosions from munitions such as bombs and missiles actually occur upon impact with above-water targets. However, for this analysis, sources such as these were modeled as exploding at 1 m depth. This overestimates the amount of explosive and acoustic energy entering the water and therefore overestimates effects on marine mammals.

6.9.13.1 ***Blue Whale***

Blue whales may be exposed to sound or energy from explosions associated with testing activities throughout the year, although the acoustic analysis predicts that no blue whales would be impacted. Although ESA-listed blue whales are present in the Study Area, it is unlikely that explosive stressors and this species would co-occur based on the expected locations of testing, best available science regarding marine mammal densities, and the typical short duration of the activities. Even with use of conservative assumptions in the acoustic impacts modeling, criteria, and thresholds, the quantitative analysis of acoustic impacts predicts that this species is unlikely to be affected by the use of explosives.

6.9.13.2 ***Fin Whale***

Fin whales may be exposed to sound or energy from explosions associated with annual and non-annual testing activities throughout the year, the acoustic analysis predicts that one fin whale would be experience TTS from annual testing while another instance of TTS would result from non-annual testing.

6.9.13.3 ***Humpback Whale***

Humpback whales may be exposed to sound or energy from explosions associated with testing activities throughout the year, although the acoustic analysis predicts that no humpback whales would be impacted. Although ESA-listed humpback whales are present in the Study Area, it is unlikely that explosive stressors and this species would co-occur based on the expected locations of testing, best available science regarding marine mammal densities, and the typical short duration of the activities. Even with use of conservative assumptions in the acoustic impacts modeling, criteria, and thresholds, the quantitative analysis of acoustic impacts predicts that this species is unlikely to be affected by the use of explosives.

6.9.13.4 ***Sei Whale***

Sei whales may be exposed to sound or energy from explosions associated with annual and non-annual testing activities throughout a given year, the acoustic analysis predicts that one sei whale would be experience TTS during annually-recurring testing activities. Additionally, one instance of TTS and one instance of slight lung injury would result from non-annual testing. This could happen anywhere within the Study Area. Predicted impacts would be to the Nova Scotia stock since this is the only sei whale stock present within the Study Area.

6.9.13.5 ***Sperm Whale***

Sperm whales may be exposed to sound or energy from explosions associated with annual and non-annual testing activities throughout a given year, the acoustic analysis predicts that one sperm whale would be experience a behavioral response during annually-recurring testing activities. Additionally, four sperm whales would experience TTS from non-annual testing including ship shock trials. There would be a single instance of slight lung injury and one instance of mortality.

6.9.13.6 ***North Atlantic Right Whale***

North Atlantic right whales may be exposed to sound or energy from explosions associated with testing activities throughout the year, although the acoustic analysis predicts no impacts on North Atlantic right whales. Although ESA-listed North Atlantic right whales are present in the Study Area, it is unlikely that explosive stressors and this species would co-occur based on the expected locations of testing, best available science regarding marine mammal densities, and the typical short duration of the activities. Even with use of conservative assumptions in the acoustic impacts modeling, criteria, and thresholds, the quantitative analysis of acoustic impacts predicts that this species is unlikely to be affected by the use of explosives

Testing activities that use explosives would not occur in the North Atlantic right whale mitigation areas. The sound and energy from explosions associated with testing activities under the No Action Alternative would not impact the assumed primary constituent elements of the North Atlantic right whale critical habitats (i.e., water temperature and depth in the southeast and copepods in the northeast).

6.9.13.7 ***Ringed Seal – Arctic DPS***

The Arctic DPS of ringed seals may be exposed to sound or energy from explosions associated with testing activities throughout the year, although the acoustic analysis predicts no impacts on ringed seals. Although ringed seals are present in the Study Area, it is unlikely that explosive stressors and this species would co-occur based on the expected locations of testing, best available science regarding marine mammal densities, and the typical short duration of the activities. Even with use of conservative assumptions in the acoustic impacts modeling, criteria, and thresholds, the quantitative analysis of acoustic impacts predicts that this species is unlikely to be affected by the use of explosives.

6.9.14 **Response of Sea Turtles to Impulsive Acoustic Stressors During Testing Activities**

Exposures that result in injuries such as nonlethal trauma and PTS may limit an animal's ability to find or obtain food, communicate with other animals, avoid predators, and interpret the environment around it. Impairment of these abilities can decrease an individual's chance of survival or impact its ability to successfully reproduce. Mortality of an animal will remove the animal entirely from the population as well as eliminate its future reproductive potential.

There is some limited information on sea turtle behavioral responses to impulsive noise from airgun studies that can be used as a surrogate for explosive impact analysis. Any behavioral response to a single detonation would likely be a short-term startle response, if the animal responds at all. Multiple detonations over a short period may cause an animal to exhibit other behavioral reactions, such as interruption of feeding or avoiding the area.

The average ranges to impacts from explosions of different charge weights for each of the specific criteria (onset mortality, onset slight lung injury, onset slight gastrointestinal tract injury, PTS, and TTS). Sea turtles within the ranges to effects are predicted by the model to receive the associated impact. Information regarding the ranges to impacts is important not only for predicting acoustic impacts but also for verifying the accuracy of model results against real-world situations and determining adequate mitigation ranges to avoid higher level impacts, especially physiological impacts on sea turtles. Because propagation of the acoustic waves is affected by environmental factors at different locations and because some criteria are partially based on sea turtle mass, the range of impacts for particular criteria will vary.

Based on the estimate of sound exposure level that could induce a sea turtle to exhibit avoidance behavior when exposed to repeated impulsive, the distance from an explosion at which a sea turtle may behaviorally react (e.g., avoid by moving farther away) can be estimated. If exposed to a single impulsive sound, a sea turtle is assumed to exhibit a brief startle reaction that would likely be biologically insignificant.

A region of cavitation may occur between a large underwater detonation and the water surface where the reflected shock wave causes a region of water tension. When this region collapses, a change in direction of the pressure wave can be created. During ship shock trial detonations, the cavitation region could extend beyond 1.1 nm at depths less than 30 m from the water surface (Craig and Rye 2008). Animals in this region could be killed or injured. Because the estimated cavitation range is less than the range to onset mortality for explosives used during ship shock trials (source class E16 and E17), any mortalities or injuries due to cavitation are accounted for within the impacts for onset mortality.

Table 147 below presents predicted impacts on sea turtles from annual explosive detonations estimated by the Navy Acoustic Effects Model, applying the impact threshold criteria.

Table 147. Annual U.S. Navy Model-Predicted Impacts on Sea Turtles from Impulsive Sound (Explosives) for Testing Activities

Sea Turtle Species or Group	Temporary Threshold Shift	Permanent Threshold Shift	GI Tract Injury	Slight Lung Injury	Mortality
Hardshell Turtles[1]	55	7	0	4	5
Kemp's Ridley Turtle	6	0	0	0	2
Loggerhead Turtle	81	7	0	5	5
Leatherback Turtle	17	2	0	1	0

Sea Turtle Species or Group	Temporary Threshold Shift	Permanent Threshold Shift	GI Tract Injury	Slight Lung Injury	Mortality

GI: gastrointestinal
Predicted impacts exclude those from ship shock trials.
[1] The Hardshell Turtles category includes a combined density estimate for green, hawksbill, and all unidentified hardshell turtles. There is no separate density estimate for green or hawksbill sea turtles.

Table 148 and Table 149 provide estimated impacts from non-annual testing events. The impact estimates for each alternative represent the total number of impacts and not necessarily the number of individuals exposed, as a single individual may be exposed multiple times over the course of a year.

Table 148.Annual U.S. Navy Model-Predicted Impacts on Sea Turtles from Impulsive Sound (Explosives) During Aircraft Carrier Ship Shock Trial

Sea Turtle Species or Group	Temporary Threshold Shift	Permanent Threshold Shift	GI Tract Injury	Slight Lung Injury[2]	Mortality[2]
Hardshell Turtles[1]	74	2	0	215	40
Kemp's Ridley Turtle	5	0	0	16	2
Loggerhead Turtle	83	5	0	531	67
Leatherback Turtle	120	15	0	126	48

GI: gastrointestinal
Event would occur once per five-year period. Event uses up to four source class E17 charges (14,501–58,000 pounds [lb.] net explosive weight). Detonations are separated by about one week. Predicted impacts are the sum of impacts from the four detonations over one ship shock trial.

[1] The Hardshell Turtles category includes a combined density estimate for green, hawksbill, and all unidentified hardshell turtles. There is no separate density estimate for green or hawksbill sea turtles.

[2] For larger detonations, such as those that occur during ship shock trials, the range to onset of impacts based on impulse criteria (slight lung injury and mortality) may overtake a portion of the range to pressure and sound exposure level based impacts (temporary threshold shift, permanent threshold shift, and GI tract injury).

Table 149.Annual U.S. Navy Model-Predicted Impacts on Sea Turtles from Impulsive Sound (Explosives) During Guided Missile Destoyer and Littoral Combat Ship Shock Trial (per single, full ship shock trial event held once during the five-year period using Class E16 Charges)

Sea Turtle Species or Group	Temporary Threshold Shift	Permanent Threshold Shift	GI Tract Injury	Slight Lung Injury[2]	Mortality[2]
Hardshell Turtles[1]	38	1	0	23	4
Kemp's Ridley Turtle	3	0	0	1	0
Loggerhead Turtle	49	3	0	42	9
Leatherback Turtle	90	12	0	35	9

Sea Turtle Species or Group	Temporary Threshold Shift	Permanent Threshold Shift	GI Tract Injury	Slight Lung Injury[2]	Mortality[2]

GI: gastrointestinal

Guided Missile Destroyer event would occur once per five-year period. Event uses up to four source class E16 charges (7,251–14,500 pound [lb.] net explosive weight). Detonations are separated by about one week. Predicted impacts are the sum of impacts from the four detonations over one ship shock trial.

Littoral Combat Ship event would occur twice per five-year period. Event uses up to four source class E16 charges (7,251–14,500 lb. net explosive weight). Detonations are separated by about one week. Predicted impacts are the sum of impacts from the four detonations over one ship shock trial.

[1] The Hardshell Turtles category includes a combined density estimate for green, hawksbill, and all unidentified hardshell turtles. There is no separate density estimate for green or hawksbill sea turtles.

[2] For larger detonations, such as those that occur during ship shock trials, the range to onset of impacts based on impulse criteria (slight lung injury and mortality) may overtake a portion of the range to pressure and sound exposure level based impacts (temporary threshold shift, permanent threshold shift, and GI tract injury).

Some of the conservative assumptions made for the Navy's impact modeling and criteria may cause the impact predictions to be overestimated, as follows:

- Many explosions from munitions such as bombs and missiles actually explode upon impact with above-water targets. For this analysis, sources such as these were modeled as exploding at depths of 1 m, overestimating the amount of explosive and acoustic energy entering the water.
- For predicting TTS and PTS based on sound exposure level, the duration of an explosion is assumed to be one second. Actual detonation durations may be much shorter, so the actual sound exposure level at a particular distance may be lower.
- Mortality and slight lung injury criteria are based on juvenile turtle masses, which substantially increases that range to which these impacts are predicted to occur compared to the ranges that would be predicted using adult turtle masses.
- Animats are assumed to receive the full impulse of the initial positive pressure wave due to an explosion, although the impulse-based thresholds (onset mortality and onset slight lung injury) assume an impulse delivery time adjusted for animal size and depth. Therefore, these impacts are overestimated at farther distances and increased depths.
- The predicted acoustic impacts do not take into account mitigation measures implemented during many training and testing activities, such as exclusion zones around detonations. Smaller hatchling and early juvenile hardshell turtles tend to be near the surface and are often associated with *Sargassum*, which is subject to avoidance mitigation measures.

6.9.15 **Response of Fish to Impulsive Acoustic Stressors During Testing Activities**

Explosions and other impulsive sound sources include explosions from underwater detonations and explosive munitions, swimmer defense airguns, and noise from weapons firing, launch, and impact with the water's surface. Potential acoustic effects to fish from impulsive sound sources may be considered in four categories (1) direct injury; (2) hearing loss; (3) auditory masking; and (4) physiological stress and behavioral reactions.

Concern about potential fish mortality associated with the use of at-sea explosives led military researchers to develop mathematical and computer models that predict safe ranges for fish and other animals from explosions of various sizes (e.g., Goertner 1982; Goertner et al. 1994; Yelverton et al. 1975a). Young (1991) provides equations that allow estimation of the potential effect of underwater explosions on fish possessing swim bladders using a damage prediction method developed by Goertner (1982). Young's parameters include the size of the fish and its location relative to the explosive source, but are independent of environmental conditions (e.g., depth of fish and explosive shot frequency).

Fish not killed or driven from a location by an explosion might change their behavior, feeding pattern, or distribution. Changes in behavior of fish have been observed as a result of sound produced by explosives, with effect intensified in areas of hard substrate (Wright 1982). Stunning from pressure waves could also temporarily immobilize fish, making them more susceptible to predation.

The number of fish killed by an underwater explosion would depend on the population density in the vicinity of the blast, as well as factors discussed above such as net explosive weight, depth of the explosion, and fish size. For example, if an explosion occurred in the middle of a dense school of menhaden, herring, or other schooling fish, a large number of fish could be killed. Furthermore, the probability of this occurring is low based on the patchy distribution of dense schooling fish.

Testing activities would involve underwater detonations and explosive practice munitions. Testing activities involving explosions could be conducted throughout the Study Area but would be concentrated in the VACAPES Range Complex, followed by the JAX Range Complex. These events would be concentrated in the Northeast U.S. Continental Shelf, Southeast U.S. Continental Shelf Large Marine Ecosystems and the Gulf Stream Open Ocean Area. Testing activities using explosions do not normally occur within 3 nm of shore; the exception is the designated underwater detonation area near Naval Surface Warfare Center, Panama City Division Testing Range, which is located nearshore, partially within the surf zone

Testing activities produce in water noise from weapons firing, launch, and non-explosive practice munitions impact with the water's surface. Activities are spread throughout the Study Area but would be concentrated in the Gulf of Mexico and Northeast Range Complexes. These activities could take place within any large marine ecosystem or open ocean area, but would be concentrated within the Northeast U.S. Continental Shelf and Gulf of Mexico Large Marine Ecosystems and the Gulf Stream Open Ocean Area.

Testing activities would include the use of swimmer defense airguns at Joint Expeditionary Base Little Creek, Virginia up to three times per year, and pierside at Newport, Rhode Island up to six times per year. Both of these areas are located within the inland waters of the Northeast U.S. Continental Shelf Large Marine Ecosystem. Stationary source testing at Naval Surface Warfare Center, Panama City Division Testing Range includes a limited amount of swimmer defense airgun use and could occur up to 11 times per year. This area is located in inland waters, within the Gulf of Mexico Large Marine Ecosystem.

Single, small airguns (60 cubic inches [983 cubic centimeters]) are unlikely to cause direct trauma to marine fish. Impulses from airguns lack the strong shock wave and rapid pressure increase, as would be expected from explosive sources that can cause primary blast injury or barotrauma. There is little evidence that airguns can cause direct injury to adult fish, with the possible exception of injuring small juvenile or larval fish nearby (approximately 5 m [16 ft.]). Therefore, larval and small juvenile fish within a few meters of the airgun may be injured or killed. Considering the small footprint of this hypothesized injury zone, and the isolated and infrequent use of the swimmer defense airgun, population consequences would not be expected.

Temporary hearing loss in fish could occur if fish were exposed to impulses from swimmer defense airguns, although some studies show no hearing loss from exposure to airguns within 5 m (16 ft.). Therefore, fish within a few meters of the airgun may receive temporary hearing loss. However, due to the relatively small size of the airgun, and their limited use in pierside areas, impacts would be minor, and may only impact a few individual fish.

Airguns do produce broadband sounds; however, the duration of an individual impulse is about $1/10^{th}$ of a second. Airguns could be fired up to 100 times per event, but would generally be used less based on the actual testing requirements. The pierside areas where these activities are proposed are inshore, with high levels of use, and therefore have high levels of ambient noise. Auditory masking only occurs when the interfering signal is present. Due to the limited duration of individual shots and the limited number of shots proposed for the swimmer defense airgun, only brief, isolated auditory masking to marine fish would be expected.

In addition, fish that are able to detect the airgun impulses may exhibit alterations in natural behavior. Some fish species with site fidelity such as reef fish may show initial startle reactions, returning to normal behavioral patterns within a matter of a few minutes. Pelagic and schooling fish that typically show less site fidelity may avoid the immediate area for the duration of the events. Due to the limited use and relatively small footprint of swimmer defense airguns, impacts to fish are expected to be minor.

6.9.15.1 ***Gulf Sturgeon***

Gulf sturgeon, when not spawning in the rivers, are found in the Gulf of Mexico in nearshore and inshore waters. They typically range in distribution from Louisiana through the panhandle of Florida (U.S. Fish and Wildlife Service and National Marine Fisheries Service 2009).

Underwater explosions, particularly those associated with mine warfare testing that occur in shallow water areas of the Naval Surface Warfare Center, Panama City Division Testing Range, may coincide with areas Gulf sturgeon frequent. Exposures may result in behavioral responses, hearing loss, physical injury, or death to fish near the activities. Due to the lack of information on distribution and density of individuals during testing activities, we are unable to quantify the number of individuals or extent of potential responses to impulsive acoustic stressors.

Proposed testing activities overlap designated critical habitat for Gulf sturgeon within one mile of the coastline in the eastern Gulf of Mexico. Most of the primary constituent elements are generally not applicable to the Study Area since they occur within the riverine habitat of the species. The use of explosive and other impulsive sources in Gulf sturgeon critical habitat are unlikely to interfere with the individuals' safe and unobstructed passage between riverine, estuarine, and marine habitats. However, part of the primary constituent elements for Gulf sturgeon critical habitat includes abundant prey items (e.g., amphipods, lancelets, polychaetes, gastropods, ghost shrimp, isopods, molluscs, and crustaceans) within estuarine and marine habitats and substrates. It is possible that the use of explosive sound sources within the critical habitat may impact the abundance of prey items within the vicinity of the sound source. Therefore, explosive sound sources used in proposed testing activities may affect Gulf sturgeon designated critical habitat, but are not likely to reduce availability of prey items in a manner that appreciably reduces the conservation value of the habitat for sturgeon in short-term.

6.9.15.2 ***Atlantic Sturgeon***

Testing activities include activities that produce in-water noise from weapons firing, launch, and non-explosive practice munitions impact with the water's surface. Activities are spread throughout the Study Area but would be concentrated in the Gulf of Mexico and Northeast Range Complexes. These activities could take place within any large marine ecosystem or open ocean area, but would be concentrated within the Northeast U.S. Continental Shelf, and Gulf of Mexico Large Marine Ecosystems and the Gulf Stream Open Ocean Area.

Testing activities would include the use of swimmer defense airguns at Joint Expeditionary Base Little Creek, Virginia up to three times per year, and pierside at Newport, Rhode Island up to six times per year. Both of these areas are located within the inland waters of the Northeast U.S. Continental Shelf Large Marine Ecosystem. Stationary source testing at Naval Surface Warfare Center, Panama City Division Testing Range includes a limited amount of swimmer defense airgun use and could occur up to 11 times per year. This area is located in inland waters, within the Gulf of Mexico Large Marine Ecosystem.

Impacts to fish due to exposure to impulsive sound and especially explosive energy could be injured, killed, suffer hearing loss, or alter natural behavior patterns. Due to the lack of information on distribution and density of individuals during testing activities, we are unable to quantify the number of individuals or extent of potential responses to impulsive acoustic stressors.

Underwater explosions, particularly those associated with mine warfare testing that occur in shallow water areas of the Naval Surface Warfare Center, Panama City Division Testing Range, may coincide with areas Atlantic sturgeon frequent. Exposures may result in behavioral responses, hearing loss, physical injury, or death to fish near the activities.

6.9.15.3 ***Smalltooth Sawfish***

The distribution of the smalltooth sawfish has contracted greatly over the past several decades and is believed to be restricted now primarily to Florida waters (Simpfendorfer 2006; Simpfendorfer and Wiley 2006), as described in Section 3.9.2.5 (Smalltooth Sawfish [*Pristis pectinata*]). However, verified encounters over the past 15 years have been noted within the Panama City OPAREA and the Key West Range Complex in the Gulf of Mexico and in the JAX Range Complex along the east coast of the United States (Simpfendorfer and Wiley 2006). Typically, smalltooth sawfish prefer nearshore, coastal habitats, but it is not uncommon for larger adults to occur in deeper waters ranging from 230 to 400 ft. (70 to 120 m) in depth (Poulakis and Seitz 2004b; Simpfendorfer 2006).

Impacts to fish due to exposure to impulsive sound and especially explosive energy could be injured, killed, suffer hearing loss, or alter natural behavior patterns. Underwater explosions, particularly those associated with mine warfare testing that occur in shallow water areas of the Naval Surface Warfare Center, Panama City Division Testing Range, may coincide with areas smalltooth sawfish frequent. Exposures may result in behavioral responses, hearing loss, physical injury, or death to fish near the activities. Due to the lack of information on distribution and density of individuals during testing activities, we are unable to quantify the number of individuals or extent of potential responses to impulsive acoustic stressors.

The Key West Range Complex does not overlap with critical habitat areas; the northeastern boundary (W-174G) of the Key West Range Complex is within approximately 9 nm [17 km] of critical habitat at its closest point. Therefore, proposed training activities are unlikely to take place within smalltooth sawfish critical habitat, although sound from activities involving impulsive sound sources that take place near the Key West Range Complex boundary may be present within the critical habitat. The primary constituent elements (i.e., red mangroves and shallow water less than 3 ft. [0.9 m] deep) would not be affected.

6.10 Cumulative Effects

Cumulative effects include the effects of future State, tribal, local, or private actions that are reasonably certain to occur in the action area considered in this biological opinion. Future Federal actions that are unrelated to the proposed action are not considered in this section because they require separate consultation pursuant to section 7 of the ESA.

During this consultation, NMFS searched for information on future State, tribal, local, or private actions that were reasonably certain to occur in the action area. Most of the action area includes federal military reserves or is outside of territorial waters of the United States of America, which would preclude the possibility of future state, tribal, or local action that would not require some form of federal funding or authorization. NMFS conducted electronic searches of business journals, trade journals, and newspapers using *First Search*, Google, and other electronic search engines. Those searches produced no evidence of future private action in the action area that would not require federal authorization or funding and is reasonably certain to occur. As a result, NMFS is not aware of any actions of this kind that are likely to occur in the action area during the reasonably foreseeable future.

7 Integration and Synthesis Of Effects

In the *Assessment Approach* section of this opinion, our risk analyses begin by identifying the probable risks actions pose to listed individuals that are likely to be exposed to an action's effects. We measure risks to individuals of endangered or threatened species using changes in the individuals' "fitness" or the individual's growth, survival, annual reproductive success, and lifetime reproductive success. When we do not expect listed animals exposed to an action's effects to experience reductions in fitness, we would not expect the action to have adverse consequences on the viability of the populations those individuals represent or the species those populations comprise (Anderson 2000b; Brandon 1978; Mills and Beatty 1979; Stearns 1977; Stearns 1992b). As a result, if we conclude that listed animals are *not* likely to experience reductions in their fitness, we would conclude our assessment. If, however, we conclude that listed plants or animals are likely to experience reductions in their fitness, we would assess the potential consequences of those fitness reductions for the population or populations the individuals in an action area represent.

As part of our risk analyses, we consider the consequences of exposing endangered or threatened species to the stressors associated with the proposed actions, individually and cumulatively, given that the individuals in the action areas for this consultation are also exposed to other stressors in the action area and elsewhere in their geographic range. These stressors or the response of individual animals to those stressors can produce consequences — or "cumulative impacts" (in the NEPA sense of the term) — that would not occur if animals were only exposed to a single stressor.

Our analyses led us to conclude, first, whether endangered or threatened individuals are likely to be exposed to the U.S. Navy's training exercises and testing activities in the AFTT Study Area during the five year period of the MMPA rule and LOAs and continuing for the reasonably foreseeable future. We then assessed whether or not those individuals exposed to training and/or activities are likely to experience reductions in the fitness during this period and continuing into the reasonably foreseeable future as training and testing activities likely to continue at similar levels. We assumed that the activities proposed for the next five years would continue into the foreseeable future at levels similar to that assessed in this opinion, and we considered the direct and indirect effects of those assumed future activities, together with the effects of all interrelated and interdependent actions.

7.1.1 **Cetaceans**

As we discussed in our exposure and response analysis, the following impulsive and non-impulsive acoustic stresssors resulting from active sonar and explosions are likely to adversely affect large whales in the AFTT Study Area. Additionally, physical disturbance and strike by vessels are also likely in a given year over the five-year period and would be expected to continue in the reasonably foreseeable future in association with ongoing activities. Our conclusions on specific impacts to ESA-listed mysticete and odontocete whales are summarized below:

7.1.1.1 ***Blue Whale***

Most blue whales would only be exposed periodically or episodically, if at all, to the activities the U.S. Navy proposes to conduct in the AFTT Study Area over a five-year period. Many training exercises and testing activities will occur without any marine animals being exposed to U.S. Navy vessels, sound fields associated with active sonar pings, or shock waves associated with underwater detonations.

Based on our risk analysis on annual and non-annual training activities, we conclude that in any given year during the five-year period (November 2013-November 2018), blue whales could potentially experience up to 50 instances of take in the form of behavioral harassment resulting from non-impulsive acoustic stressors. Additionally, we anticipate no more than 97 takes per year in the form of harassment from temporary threshold shifts (TTS) resulting from non-impulsive sound stressors. We do not anticipate any take in the form of injury from permanent threshold shift (PTS) or other injuries such as GI tract or lung injury during annual or non-annual training activities. We do not anticipate any mortality of blue whales from acoustic stressors; however up to three (3) deaths in a given year not to exceed 10 deaths over the five year period could occur as a result of vessel strike. While the potential exists for up to three mortalities per year, we do not anticipate that all three potential strikes would consist of blue whales.

During testing activities, blue whales could potentially experience up to six (6) instances of take in the form of behavioral harassment resulting from non-impulsive acoustic stressors. Additionally, we anticipate no more than 12 takes per year in the form of harassment from temporary threshold shifts (TTS) resulting from non-impulsive sound stressors. We do not anticipate any take in the form of injury from permanent threshold shift (PTS) or other injuries such as GI tract or lung injury during annual or non-annual testing activities. We do not anticipate any mortality of blue whales from acoustic stressors; however up to one (1) death in a given year not to exceed one (1) death over the five year period could occur as a result of vessel strike. While the potential exists for up to one mortality per year, we do not anticipate more than one in five years.

The estimates of exposures to training exercises and exposures (NAEMO) to testing exercises that would result in a behavioural response annually are probably an over-estimate of the actual exposures even if it represents the best estimate available. While some blue whales detect and respond to mid-frequency active sonar, mid-frequency active sonar is considered to be at the periphery of blue whale hearing sensitivity.

Blue whales in the action area seem likely to respond to the ship traffic associated with each of the activities in ways that approximate their responses to whale watch vessels. Those responses are likely to depend on the distance of a whale from a vessel, vessel speed, vessel direction, vessel noise, and the number of vessels involved in a particular maneuver, as well as the activity the whale is involved with at the time. Blue whales seem most likely to try to avoid being exposed to the activities and their avoidance response is likely to increase as an exercise progresses. We do not have the information necessary to determine which of the many sounds associated with an activity is likely to trigger avoidance behavior in blue whales (for example, engine noise, helicopter rotors, ordnance discharges, explosions, or some combination of these) or whether blue whales would avoid being exposed to specific received levels, the entire sound field associated with an exercise, or the general area in which an exercise would occur.

Individual blue whales' might not respond to the vessels, while in other circumstances, whales are likely to change their surface times, swimming speed, swimming angle or direction, respiration rates, dive times, feeding behavior, and social behavior. Some of these whales might experience physiological stress (but not "distress") responses if they attempt to avoid one ship and encounter a second ship during that attempt. However, because of the relatively short duration of individual activity, the small number of large exercises, and the short duration of the unit- or intermediate-level training exercise and testing activities, we do not expect these responses of blue whales to reduce the fitness of those whales.

Based on the evidence available, including the environmental baseline and cumulative effects, we conclude that impulsive and non-impulsive acoustic stressors resulting from training exercises and testing activities the U.S. Navy plans to conduct in the AFTT Study Area on an annual basis, or cumulatively over the five year period from November 2013 through November 2018, or cumulatively for the reasonably foreseeable future (assuming there are no significant changes to the status of the species or Environmental Baseline), are not likely to adversely affect the population dynamics, behavioral ecology, and social dynamics of individual blue whales in ways or to a degree that would reduce their fitness. An action that is not likely to reduce the fitness of individual whales would not be likely to reduce the viability of the populations those individual whales represent (that is, we would not expect reductions in the reproduction, numbers, or distribution of those populations).

In the event of one or more vessel strikes to blue whales resulting in severe injury or mortality, individuals would likely experience significant fitness consequences that may affect feeding and reproduction or would be totally removed from a population. Removal of one or more individuals of a particular species from a population will have different consequenses on the population depending on sex and maturity of the animal.

7.1.1.2 ***Fin Whale***

Most fin whales would only be exposed periodically or episodically, if at all, to the activities the U.S. Navy proposes to conduct in the AFTT Study Area. Many training exercises and testing activities will occur without any marine animals being exposed to U.S. Navy vessels, sound fields associated with active sonar pings, or shock waves associated with underwater detonations.

Based on our risk analysis on annual and non-annual training activities, we conclude that in any given year during the five-year period (November 2013-November 2018), fin whales could potentially experience up to 1,609 instances of take in the form of behavioral harassment resulting from impulsive (1 instance) and non-impulsive (1,608 instances) acoustic stressors. Additionally, we anticipate no more than 2,881 takes per year in the form of harassment from temporary threshold shifts (TTS) resulting from non-impulsive (2,880 instances) and impulsive (1 instance) sound stressors. We anticipate a maximum of one (1) take by injury in the form of permanent threshold shift (PTS) resulting from non-impulsive acoustic stressors, but do not anticipate other injuries such as GI tract or lung injury from annual or non-annual training activities. We do not anticipate any mortality of fin whales from acoustic stressors; however up to three (3) deaths in a given year not to exceed 10 deaths over the five year period could occur as a result of vessel strike. While the potential exists for up to three mortalities per year, we do not anticipate that all three potential strikes would consist of fin whales.

During testing activities, fin whales could potentially experience up to 285 instances of take in the form of behavioral harassment resulting from impulsive (1 instance) and non-impulsive (284 instances) acoustic stressors. Additionally, we anticipate no more than 313 takes per year in the form of harassment from temporary threshold shifts (TTS) resulting from non-impulsive (4 instances) and impulsive (309 instance) sound stressors. We do not anticipate injury in the form of permanent threshold shift (PTS) resulting from non-impulsive acoustic stressors or other injuries such as GI tract or lung injury from annual or non-annual testing activities. We do not anticipate any mortality of fin whales from acoustic stressors; however up to one (1) death in a given year not to exceed one (1) death over the five year period could occur as a result of vessel strike. While the potential exists for up to one mortality per year, we do not anticipate more than one in five years.

The estimates of exposures to training exercises and exposures to testing activities (NAEMO) that would result in a behavioural response annually are probably an over-estimate of the actual exposures even if it represents the best estimate available. Frequencies associated with mid-frequency sonar have generally been considered above the hearing range of fin whales. However, recent observations of blue whale responses to the mid-frequency sonar sounds support the possibility that this ecologically, physiologically, and taxonomically similar species may be capable of detecting and responding to them. Additional data are necessary to determine the potential impact that mid-frequency sonar may or may not have on fin whales. Considering information presented in this opinion, we consider fin whales to be able to hear and respond to mid frequency sonar as blue whales appear to.

Fin whales in the action area seem likely to respond to the ship traffic associated with each of the activities in ways that approximate their responses to whale watch vessels. Those responses are likely to depend on the distance of a whale from a vessel, vessel speed, vessel direction, vessel noise, and the number of vessels involved in a particular maneuver, as well as the activity the whale is involved with at the time. Fin whales seem most likely to try to avoid being exposed to the activities and their avoidance response is likely to increase as an exercise progresses. We do not have the information necessary to determine which of the many sounds associated with an activity is likely to trigger avoidance behavior in fin whales (for example, engine noise, helicopter rotors, ordnance discharges, explosions, or some combination of these) or whether fin whales would avoid being exposed to specific received levels, the entire sound field associated with an exercise, or the general area in which an exercise would occur.

Particular fin whales' might not respond to the vessels, while in other circumstances, fin whales are likely to change their surface times, swimming speed, swimming angle or direction, respiration rates, dive times, feeding behavior, and social interactions. Some of these whales might experience physiological stress (but not "distress") responses if they attempt to avoid one ship and encounter a second ship during that attempt. However, because of the relatively short duration of individual activities, the small number of large exercises, and the short duration of the unit- or intermediate-level training exercises, we do not expect these responses of fin whales to reduce the fitness of those whales.

Based on the evidence available, including the environmental baseline and cumulative effects, we conclude that impulsive and non-impulsive acoustic stressors resulting from training exercises and testing activities the U.S. Navy plans to conduct in the AFTT Study Area on an annual basis, or cumulatively over the five year period from November 2013 through November 2018, or cumulatively for the reasonably foreseeable future (assuming there are no significant changes to the status of the species or Environmental Baseline), are not likely to adversely affect the population dynamics, behavioral ecology, and social dynamics of individual fin whales.

In the event of one or more vessel strikes to fin whales resulting in severe injury or mortality, individuals would likely experience significant fitness consequences that may affect feeding and reproduction or would be totally removed from a population. Removal of one or more individuals of a particular species from a population will have different consequenses on the population depending on sex and maturity of the animal.

7.1.1.3 ***Humpback Whale***

Most humpback whales would only be exposed periodically or episodically, if at all, to the activities the U.S. proposes to conduct in the AFTT Study Area. Many training exercises or testing activities will occur without any marine animals being exposed to U.S. Navy vessels, sound fields associated with active sonar pings, or shock waves associated with underwater detonations.

Based on our risk analysis on annual and non-annual training activities, we conclude that in any given year during the five year period (November 2013-November 2018), humpback whales could potentially experience up to 514 instances of behavioral harassment resulting from non-impulsive acoustic stressors. Additionally, we anticipate no more than 1,129 instances per year of harassment in the form of temporary threshold shifts (TTS) resulting from non-impulsive (1,128 instances) and impulsive (1 instance) sound stressors. We anticipate one (1) instance of injury in the form of permanent threshold shift (PTS) resulting from non-impulsive acoustic stressors, but do not anticipate other injuries such as GI tract or lung injury from annual or non-annual training activities. We do not anticipate any mortality of humpback whales from acoustic stressors; however up to three (3) deaths in a given year not to exceed 10 deaths over the five year period could occur as a result of vessel strike. While the potential exists for three mortalities per year, we do not anticipate that all three potential strikes would consist of humpback whales.

During testing activities, humpback whales could potentially experience up to 100 instances of behavioral harassment resulting from non-impulsive acoustic stressors. Additionally, we anticipate no more than 100 instances per year of harassment in the form of temporary threshold shifts (TTS) resulting from non-impulsive (99 instances) and impulsive (1 instance) sound stressors. We do not anticipate injury in the form of permanent threshold shift (PTS) resulting from non-impulsive acoustic stressors and do not anticipate other injuries such as GI tract or lung injury from annual or non-annual testing activities. We do not anticipate any mortality of humpback whales from acoustic stressors; however up to one (1) death in a given year not to exceed one (1) death over the five year period could occur as a result of vessel strike. While the potential exists for up to one mortality per year, we do not anticipate more than one in five years.

The estimates of exposures to training exercises and exposures to testing activities (NAEMO) that would result in a behavioural response annually are probably an over-estimate of the actual exposures even if it represents the best estimate available.

Although studies have demonstrated that humpback whales will exhibit short-term behavioral reactions to boat traffic and playbacks of low frequency industrial noise, the long-term effects of these disturbances on the individuals exposed to them are not known.

The evidence available suggests that humpback whales are likely to detect mid-frequency sonar transmissions. In most circumstances, humpback whales are likely to try to avoid that exposure or are likely to avoid specific areas. Those humpback whales that do not avoid the sound field created by the mid-frequency sonar might experience interruptions in their vocalizations. In either case, humpback whales that avoid these sound fields or stop vocalizing are not likely to experience significant disruptions of their normal behavior patterns.

The increase in the number of humpback whales suggests that the stress regime these whales are exposed to in the AFTT Study Area has not prevented these whales from increasing their numbers in the action area. Humpback whales have been exposed to U.S. Navy training exercises in the AFTT Study Area, including vessel traffic, aircraft traffic, active sonar, and underwater detonations, for more than a generation. Although we do not know if more humpback whales might have used the action area or the reproductive success of humpback whales would be higher absent their exposure to these activities, the rate at which humpback whales occur in the AFTT Study Area suggests that humpback whale numbers have increased substantially in these important calving areas despite exposure to earlier training regimes. Although the U.S. Navy proposes to increase the frequency of some of these activities, we do not believe those increases are likely to affect the rate at which humpback whale counts are increasing.

Based on the evidence available, including the environmental baseline and cumulative effects, we conclude that impulsive and non-impulsive acoustic stressors resulting from training exercises and testing activities the U.S. Navy plans to conduct in the AFTT Study Area on an annual basis, or cumulatively over the five year period from November 2013 through November 2018, or cumulatively for the reasonably foreseeable future (assuming there are no significant changes to the status of the species or Environmental Baseline), are not likely to adversely affect the population dynamics, behavioral ecology, and social dynamics of individual humpback whales.

In the event of one or more vessel strikes to humpback whales resulting in severe injury or mortality, individuals would likely experience significant fitness consequences that may affect feeding and reproduction or would be totally removed from a population. Removal of one or more individuals of a particular species from a population will have different consequenses on the population depending on sex and maturity of the animal.

7.1.1.4 ***North Atlantic Right Whale***

Based on our risk analysis on annual and non-annual training activities, we conclude that in any given year during the five year period (November 2013-November 2018), North Atlantic right whales could potentially experience up to 51 instances of take in the form of behavioral harassment resulting from non-impulsive acoustic stressors. Additionally, we anticipate no more than 61 takes per year in the form of harassment by temporary threshold shifts (TTS) resulting from non-impulsive (60 instances) and impulsive (1 instance) sound stressors. We do not anticipate any take from injury in the form of permanent threshold shift (PTS) or other injuries such as GI tract or lung injury from annual or non-annual training activities. Lastly, we do not anticipate any mortality of North Atlantic right whales from acoustic stressors or from vessel strike. While the potential for vessel strike exists, U.S. Navy mitigation measures specific to North Atlantic right whales are sufficient to minimize the likelihood for a strike and subsequent mortality to zero over the five year period.

During testing activities, North Atlantic right whales could potentially experience up to 66 instances of take in the form of behavioral harassment resulting from non-impulsive acoustic stressors. Additionally, we anticipate no more than 21 takes per year in the form of harassment by temporary threshold shifts (TTS) resulting from non-impulsive sound stressors. We do not anticipate any take from injury in the form of permanent threshold shift (PTS) or other injuries such as GI tract or lung injury from annual or non-annual testing activities. Lastly, we do not anticipate any mortality of North Atlantic right whales from acoustic stressors or from vessel strike. While the potential for vessel strike exists, U.S. Navy mitigation measures specific to North Atlantic right whales are sufficient to minimize the likelihood for a strike and subsequent mortality to zero over the five year period.

Based on the evidence available, including the environmental baseline and cumulative effects, we conclude that impulsive and non-impulsive acoustic stressors resulting from training exercises and testing activities the U.S. Navy plans to conduct in the AFTT Study Area on an annual basis, or cumulatively over the five year period from November 2013 through November 2018, or cumulatively for the reasonably foreseeable future (assuming there are no significant changes to the status of the species or Environmental Baseline), are not likely to adversely affect the population dynamics, behavioral ecology, and social dynamics of individual North Atlantic right whales.

In the event of one or more vessel strikes to North Atlantic right whales resulting in severe injury or mortality, individuals would likely experience significant fitness consequences that may affect feeding and reproduction or would be totally removed from a population. Removal of one or more individuals from the estimated North Atlantic right whale population could have significant consequenses on the ability of the population to recover depending on sex and maturity of the animal.

7.1.1.5 ***Sei Whale***

As with the other whale species, this is probably an over-estimation of the actual number of sei whales that might be exposed to one or more of the training exercises or testing activities. Most marine mammals would only be exposed periodically or episodically, if at all, to the activities the U.S. proposes to conduct in the AFTT Study Area. Many training exercises and testing activities will occur without any marine animals being exposed to U.S. Navy vessels, sound fields associated with active sonar pings, or shock waves associated with underwater detonations.

Based on our risk analysis on annual and non-annual training activities, we conclude that in any given year during the five year period (November 2013-November 2018), sei whales could potentially experience up to 3,583 instances of behavioral harassment resulting from impulsive (1 instance) and non-impulsive (3,582 instances) acoustic stressors. Additionally, we anticipate no more than 6,605 instances per year of harassment in the form of temporary threshold shifts (TTS) resulting from non-impulsive (6,604 instances) and impulsive (1 instance) sound stressors. We anticipate a maximum of one (1) instance of injury in the form of permanent threshold shift (PTS) resulting from non-impulsive acoustic stressors, but do not anticipate other injuries such as GI tract or lung injury from annual or non-annual training activities. We do not anticipate any mortality of sei whales from acoustic stressors; however up to three (3) deaths in a given year not to exceed 10 deaths over the five year period could occur as a result of vessel strike. While the potential exists for up to three mortalities per year, we do not anticipate that all three potential strikes would consist of sei whales.

During testing activities, sei whales could potentially experience up to 318 instances of behavioral harassment resulting from impulsive (1 instance) and non-impulsive (317 instances) acoustic stressors. Additionally, we anticipate no more than 478 instances per year of harassment in the form of temporary threshold shifts (TTS) resulting from non-impulsive (8 instances) and impulsive (472 instance) sound stressors. We do not anticipate injury in the form of permanent threshold shift (PTS) resulting from non-impulsive acoustic stressors or other injuries such as GI tract or lung injury from annual or non-annual testing activities. We do not anticipate any mortality of sei whales from acoustic stressors; however up to one (1) death in a given year not to exceed one (1) death over the five year period could occur as a result of vessel strike. While the potential exists for up to one mortality per year, we do not anticipate more than one in five years.

The estimates of exposures to training exercises and exposures to testing activities that result in behavioural responses annually are probably an over-estimate of the actual exposures even if it represents the best estimate available. Nevertheless, sei whales are not likely to respond to mid-frequency active sonar because they are not likely to hear those sonar transmissions.

We have no specific information on the sounds produced by sei whales or their sensitivity to sounds in their environment. Based on their anatomical and physiological similarities to both blue and fin whales, we assume that the hearing thresholds of sei whales will be similar as well and will be centered on low-frequencies in the 10-200 Hz. This information would lead us to conclude that, like blue and fin whales, sei whales exposed to these received levels of active mid-frequency sonar are not likely to respond if they are exposed to mid-frequency sounds.

Sei whales seem likely to respond to the ship traffic associated with each of the activities in ways that approximate their responses to whale watch vessels. Those responses are likely to depend on the distance of a whale from a vessel, vessel speed, vessel direction, vessel noise, and the number of vessels involved in a particular maneuver, as well as the activity the whale is involved with at the time. Sei whales seem most likely to try to avoid being exposed to the activities and their avoidance response is likely to increase as an exercise progresses. We do not have the information necessary to determine which of the many sounds associated with an activity is likely to trigger avoidance behavior in sei whales (for example, engine noise, helicopter rotors, ordnance discharges, explosions, or some combination of these) or whether sei whales would avoid being exposed to specific received levels, the entire sound field associated with an exercise, or the general area in which an exercise would occur.

Particular sei whales' might not respond to the vessels, while in other circumstances, sei whales are likely to change their surface times, swimming speed, swimming angle or direction, respiration rates, dive times, feeding behavior, and social interactions. Some of these whales might experience physiological stress (but not "distress") responses if they attempt to avoid one ship and encounter a second ship during that attempt. However, because of the relatively short duration of individual activities, the small number of large exercises, and the short duration of the unit- or intermediate-level training exercises activities, we do not expect these responses of sei whales to reduce the fitness of those whales.

Based on the evidence available, including the environmental baseline and cumulative effects, we conclude that impulsive and non-impulsive acoustic stressors resulting from training exercises and testing activities the U.S. Navy plans to conduct in the AFTT Study Area on an annual basis, or cumulatively over the five year period from November 2013 through November 2018, or cumulatively for the reasonably foreseeable future (assuming there are no significant changes to the status of the species or Environmental Baseline), are not likely to adversely affect the population dynamics, behavioral ecology, and social dynamics of individual sei whales.

In the event of one or more vessel strikes to sei whales resulting in severe injury or mortality, individuals would likely experience significant fitness consequences that may affect feeding and reproduction or would be totally removed from a population. Removal of one or more individuals of a particular species from a population will have different consequenses on the population depending on sex and maturity of the animal.

7.1.1.6 ***Sperm Whale***

Based on our risk analysis on annual and non-annual training activities, we conclude that in any given year during the five-year period (November 2013-November 2018), sperm whales could potentially experience up to 14,313 instances of take in the form of behavioral harassment resulting from impulsive (1 instance) and non-impulsive acoustic stressors (14,212 instances). Additionally, we anticipate no more than 436 takes per year in the form of harassment from temporary threshold shifts (TTS) resulting from impulsive (1 instance) and non-impulsive sound stressors (435 instances). We do not anticipate any take in the form of injury from permanent threshold shift (PTS) or other injuries such as GI tract or lung injury during annual or non-annual training activities. We do not anticipate any mortality of sperm whales from acoustic stressors; however up to three (3) deaths in a given year not to exceed 10 deaths over the five year period could occur as a result of vessel strike. While the potential exists for up to three mortalities per year, we do not anticipate that all three potential strikes would consist of sperm whales.

During testing activities, sperm whales could potentially experience up to 1,103 instances of take in the form of behavioral harassment resulting from impulsive (1 instance) and non-impulsive acoustic stressors (1,102 instances). Additionally, we anticipate no more than 680 takes per year in the form of harassment from temporary threshold shifts (TTS) resulting from impulsive (14 instances) and non-impulsive sound stressors (666 instances). We do not anticipate any take in the form of injury from permanent threshold shift (PTS). Up to four (4) takes from GI tract or slight lung injury may result from explosions during annual or non-annual testing activities and from these impulsive acoustic stressors. Up to one (1) death in a given year not to exceed one

(1) death over the five year period could occur as a result of vessel strike. While the potential exists for up to one mortality per year, we do not anticipate more than one in five years.

The sperm whales involved in exposure events are likely to avoid continued exposure to mid-frequency active sonar, although we assume these whales would respond to both the active sonar, any salient acoustic cues produced by surface vessels involved in an exercise, and their perception of whether ships are approaching them or moving away when they decide whether or not to avoid the active sonar. Based on the evidence available, sperm whales seem more likely to avoid continued exposure at lower, initial received levels and the avoidance would consist of horizontal movement away from an exercise at slow to moderate swimming speeds. Sperm whales involved in exposure events may engage in evasive travel which would involve faster swimming speeds, deeper dives, and short times at surface. Some sperm whales involved in exposure events would exhibit behavioral disturbance or a shift from one behavioral state to another; they are most likely to shift from a resting behavioral state to an active behavioral state.

The U.S. Navy's analyses identified instances in which sperm whales might be exposed to pressure waves or sound fields associated with underwater detonations at received levels that would cause behaviors that would be considered behavioral harassment (as that term is defined by the MMPA) and other instances in which sperm whales might be exposed at received levels that might temporarily cause noise-induced hearing losses.

Studies suggest that the behavioral responses of sperm whales to anthropogenic sounds are highly variable, but do not appear to result in the death or injury of individual whales or result in reductions in the fitness of individuals involved. Responses of sperm whales to anthropogenic sounds probably depend on the age and sex of animals being exposed, as well as other factors. There is evidence that many individuals respond to certain sound sources, provided the received level is high enough to evoke a response, while other individuals do not.

The sperm whales that might be exposed to the activities the U.S. Navy plans to conduct in the AFTT Study Area annually, or over the five years, particularly active sonar transmissions, ship traffic, and explosions. The evidence available suggests that sperm whales are likely to detect mid-frequency sonar transmissions. In most circumstances, sperm whales are likely to try to avoid that exposure or are likely to avoid areas specific areas. Those sperm whales that do not avoid the sound field created by the mid-frequency sonar might interrupt communications, echolocation, or foraging behavior. In either case, sperm whales that avoid these sound fields, stop communcating, echolocating or foraging might experience significant disruptions of normal behavior patterns that are essential to their individual fitness. Because of the relatively short duration of the acoustic transmissions associated with the major training exercises and other anti-submarine warfare activities, we do not, however, expect these disruptions to result in the death or injury of any individual animal or to result in physiological stress responses that rise to the level of distress.

Individual sperm whales are likely to respond to the ship traffic in ways that might approximate their responses to whale watch vessels. Those responses are likely to depend on the distance of a whale from a vessel, vessel speed, vessel direction, vessel noise, and the number of vessels involved in a particular maneuver. The closer sperm whales are to these maneuvers and the greater the number of times they are exposed, the greater their likelihood of being exposed and responding to that exposure. Particular whales' might not respond to the vessels, while in other circumstances, sperm whales are likely to change their vocalizations, surface time, swimming speed, swimming angle or direction, respiration rates, dive times, feeding behavior, and social interactions. Some of these whales might experience physiological stress (but not "distress") responses if they attempt to avoid one ship and encounter a second ship during that attempt. However, because of the relatively short duration of the exercise, we do not expect these responses to continue long-enough to have fitness consequences for individual sperm whales because these whales are likely to have energy reserves sufficient to meet the demands of their normal behavioral patterns and those of a stress physiology.

Based on the evidence available, including the environmental baseline and cumulative effects, we conclude that impulsive and non-impulsive acoustic stressors resulting from training exercises and testing activities the U.S. Navy plans to conduct in the AFTT Study Area on an annual basis, or cumulatively over the five year period from November 2013 through November 2018, or cumulatively for the reasonably foreseeable future (assuming there are no significant changes to the status of the species or Environmental Baseline), are not likely to adversely affect the population dynamics, behavioral ecology, and social dynamics of individual sperm whales in ways or to a degree that would reduce their fitness. An action that is not likely to reduce the fitness of individual whales would not be likely to reduce the viability of the populations those individual whales represent (that is, we would not expect reductions in the reproduction, numbers, or distribution of those populations).

In the event of one or more vessel strikes to sperm whales resulting in severe injury or mortality, individuals would likely experience significant fitness consequences that may affect feeding and reproduction or would be totally removed from a population. Removal of one or more individuals from vessel strike will have different consequenses on the population depending on sex and maturity of the animal(s) removed.

7.1.2 **Pinnipeds**

7.1.2.1 ***Ringed Seal, Arctic DPS***

We do not anticipate any exposures to stressors during annual and non-annual training exercises in a given year, over the five-year period or in the reasonably foreseeable future (assuming training activities and levels are similar) or subsequent responses of ringed seals to those exposures to rise to the level of take.

During annual and non-annual testing activities in a given year, over the five-year period or in the reasonably foreseeable future (assuming training activities and levels are similar), ringed seals could potentially experience up to 355 instances of take in the form of behavioral harassment resulting from non-impulsive acoustic stressors. Additionally, we anticipate no more than four (4) takes per year in the form of harassment from temporary threshold shifts (TTS). We do not anticipate any take in the form of injury from permanent threshold shift (PTS) or from GI tract or slight lung injury during annual or non-annual testing activities. We do not anticipate mortality of ringed seals from acoustic stressors or vessel strike.

Based on the evidence available, including the environmental baseline and cumulative effects, we conclude that impulsive and non-impulsive acoustic stressors resulting from training exercises and testing activities the U.S. Navy plans to conduct in the AFTT Study Area on an annual basis, or cumulatively over the five year period from November 2013 through November 2018, or cumulatively for the reasonably foreseeable future (assuming there are no significant changes to the status of the species or Environmental Baseline), are not likely to adversely affect the population dynamics, behavioral ecology, and social dynamics of individual the Arctic DPS of ringed seals in ways or to a degree that would reduce their fitness. An action that is not likely to reduce the fitness of individual ringed seals would not be likely to reduce the viability of the populations those individual seals represent (that is, we would not expect reductions in the reproduction, numbers, or distribution of those populations).

7.1.3 **Sea Turtles**

Because the sonar that would be used during proposed training and testing activities transmits at frequencies above hearing thresholds for sea turtles, green, Kemp's ridley, leatherback and loggerhead turtles that are exposed to those transmissions are not likely to respond to that exposure. As a result, mid-frequency active sonar associated with the proposed exercises is not likely to adversely affect sea turtles. Other stimuli including collision with projectiles and expended materials, ingestion or entanglement with in-water devices and expended materials and exposure to underwater detonations are not likely due to densities of sea turtles at sea in the Action Area and characteristics of these stressors. Therefore, these activities are not likely to result in reductions in the fitness of the individual animals that are likely to be exposed to those activities.

We did assess that sea turtles are likely to be adversely affected by stressors resulting from direct strike with vessels and impulsive sound from underwater explosions. Our conclusions are discussed below by species.

7.1.3.1 ***Hardshell Sea Turtles***

Based on our risk analysis on annual and non-annual training activities, we conclude that in any given year during the five-year period (November 2013-November 2018), unspecified, hardshell sea turtles could potentially experience take in the form of behavioral harassment resulting from non-impulsive acoustic stressors; however, behavioral responses of turtles to acoustic stressors is poorly studied and very difficult to quantify. Therefore, we do not specify the amount or extent of take in the form of behavioral harassment. We anticipate no more than 12,216 takes per year in the form of harassment from temporary threshold shifts (TTS) resulting from impulsive (85 instances) and non-impulsive (12,131 instances) sound stressors. We also assessed up to 22 takes per year in the form of injury from permanent threshold shift (PTS) and four (4) takes per year from injuries such as GI tract or lung injury during annual or non-annual training activities. We anticipate up to two mortalities of hardshell sea turtles from acoustic stressors. While the potential for serious injury and mortality of sea turtles from vessel strike exists, it is very difficult to estimate the number and species composition of turtles that could be taken in the AFTT Study Area in transit zones and range complexes. Therefore, we do not quantify the amount or extent of take from vessel strike.

During testing activities, unspecified, hardshell sea turtles could potentially experience take in the form of behavioral harassment resulting from impulsive and non-impulsive acoustic stressors; however, behavioral responses of turtles to acoustic stressors is poorly studied and very difficult to quantify. Therefore, we do not specify the amount or extent of take in the form of behavioral harassment. We anticipate no more than 5,132 takes per year in the form of harassment from temporary threshold shifts (TTS) resulting from impulsive (167 instances) and non-impulsive (4,965 instances) sound stressors. We also assessed up to 10 takes per year in the form of injury from permanent threshold shift (PTS) and 242 takes per year from injuries such as GI tract or lung injury during annual or non-annual testing activities. We anticipate up to 49 mortalities of hardshell sea turtles from impulsive acoustic stressors each year. While the potential for serious injury and mortality of sea turtles from vessel strike exists, it is very difficult to estimate the number and species composition of turtles that could be taken in the AFTT Study Area in transit zones and range complexes. Therefore, we do not quantify the amount or extent of take from vessel strike.

Based on the evidence available, including the environmental baseline and cumulative effects, we conclude that impulsive and non-impulsive acoustic stressors resulting from training exercises and testing activities the U.S. Navy plans to conduct in the AFTT Study Area on an annual basis, or cumulatively over the five year period from November 2013 through November 2018, or cumulatively for the reasonably foreseeable future (assuming there are no significant changes to the status of the species or Environmental Baseline), are not likely to adversely affect the population dynamics, behavioral ecology, and social dynamics of individual hardshell turtles in ways or to a degree that would reduce their fitness. An action that is not likely to reduce the fitness of individual turtles would not be likely to reduce the viability of the populations those individual turtles represent (that is, we would not expect reductions in the reproduction, numbers, or distribution of those populations).

7.1.3.2 *Kemp's Ridley Sea Turtle*

Based on our risk analysis on annual and non-annual training activities, we conclude that in any given year during the five-year period (November 2013-November 2018), unspecified numbers of Kemp's ridley sea turtles could potentially experience take in the form of behavioral harassment resulting from non-impulsive acoustic stressors; however, behavioral responses of turtles to acoustic stressors is poorly studied and very difficult to quantify. Therefore, we do not specify the amount or extent of take in the form of behavioral harassment. We anticipate no more than 302 takes per year in the form of harassment from temporary threshold shifts (TTS) resulting from impulsive (39 instances) and non-impulsive (263 instances) sound stressors. We do not anticipate take in a given year or over the five-year period in the form of injury from permanent threshold shift (PTS). Approximately one (1) injury in the form of GI tract or lung injury during annual or non-annual training activities could occur and one (1) mortality from acoustic stressors could occur in a given year. While the potential for serious injury and mortality of sea turtles from vessel strike exists, it is very difficult to estimate the number and species composition of turtles that could be taken in the AFTT Study Area in transit zones and range complexes. Therefore, we do not quantify the amount or extent of take of Kemp's ridley sea turtles from vessel strike.

During testing activities, Kemp's ridley sea turtles could potentially experience take in the form of behavioral harassment resulting from impulsive and non-impulsive acoustic stressors; however, behavioral responses of turtles to acoustic stressors is poorly studied and very difficult to quantify. Therefore, we do not specify the amount or extent of take in the form of behavioral harassment. We anticipate no more than 292 takes per year in the form of harassment from temporary threshold shifts (TTS) resulting from impulsive (14 instances) and non-impulsive (278 instances) sound stressors. We do not anticipate take in a given year or over the five-year period in the form of injury from permanent threshold shift (PTS). Approximately 17 injuries in the form of GI tract or lung injury during annual or non-annual testing activities could occur and four (4) mortalities from impulsive acoustic stressors could occur in a given year. While the potential for serious injury and mortality of sea turtles from vessel strike exists, it is very difficult to estimate the number and species composition of turtles that could be taken in the AFTT Study Area in transit zones and range complexes. Therefore, we do not quantify the amount or extent of take of Kemp's ridley sea turtles from vessel strike.

Based on the evidence available, including the environmental baseline and cumulative effects, we conclude that impulsive and non-impulsive acoustic stressors resulting from training exercises and testing activities the U.S. Navy plans to conduct in the AFTT Study Area on an annual basis, or cumulatively over the five year period from November 2013 through November 2018, or cumulatively for the reasonably foreseeable future (assuming there are no significant changes to the status of the species or Environmental Baseline), are not likely to adversely affect the population dynamics, behavioral ecology, and social dynamics of individual Kemp's ridley sea turtles in ways or to a degree that would reduce their fitness. An action that is not likely to reduce the fitness of individual turtles would not be likely to reduce the viability of the populations those individual turtles represent (that is, we would not expect reductions in the reproduction, numbers, or distribution of those populations).

7.1.3.3 *Leatherback Sea Turtle*

Based on our risk analysis on annual and non-annual training activities, we conclude that in any given year during the five-year period (November 2013-November 2018), unspecified numbers of leatherback sea turtles could potentially experience take in the form of behavioral harassment resulting from non-impulsive acoustic stressors; however, behavioral responses of turtles to acoustic stressors is poorly studied and very difficult to quantify. Therefore, we do not specify the amount or extent of take in the form of behavioral harassment. We anticipate no more than 8,909 takes per year in the form of harassment from temporary threshold shifts (TTS) resulting from impulsive (103 instances) and non-impulsive (8,806 instances) sound stressors. We anticipate 23 takes in a given year or over the five-year period in the form of injury from impulsive (14 instances) and non-impulsive (9 instances) from permanent threshold shift (PTS). We also estimate approximately two (2) injuries in the form of GI tract or lung injury during annual or non-annual training activities and one (1) mortality from acoustic stressors could occur in a given year. While the potential for serious injury and mortality of sea turtles from vessel strike exists, it is very difficult to estimate the number and species composition of turtles that could be taken in the AFTT Study Area in transit zones and range complexes. Therefore, we do not quantify the amount or extent of take of leatherback sea turtles from vessel strike.

During testing activities, leatherback sea turtles could potentially experience take in the form of behavioral harassment resulting from impulsive and non-impulsive acoustic stressors; however, behavioral responses of turtles to acoustic stressors is poorly studied and very difficult to quantify. Therefore, we do not specify the amount or extent of take in the form of behavioral harassment. We anticipate no more than 6,362 takes per year in the form of harassment from temporary threshold shifts (TTS) resulting from impulsive (227 instances) and non-impulsive (6,135 instances) sound stressors. We anticipate 29 takes in a given year in the form of injury from permanent threshold shift (PTS) resulting from impulsive sound stressors such as explosions. We also estimate approximately 162 injuries in the form of GI tract or lung injury during annual or non-annual testing activities and 57 mortalities from impulsive acoustic stressors could occur in a given year. While the potential for serious injury and mortality of sea turtles from vessel strike exists, it is very difficult to estimate the number and species composition of turtles that could be taken in the AFTT Study Area in transit zones and range complexes. Therefore, we do not quantify the amount or extent of take of leatherback sea turtles from vessel strike.

Based on the evidence available, including the environmental baseline and cumulative effects, we conclude that impulsive and non-impulsive acoustic stressors resulting from training exercises and testing activities the U.S. Navy plans to conduct in the AFTT Study Area on an annual basis, or cumulatively over the five year period from November 2013 through November 2018, or cumulatively for the reasonably foreseeable future (assuming there are no significant changes to the status of the species or Environmental Baseline), are not likely to adversely affect the population dynamics, behavioral ecology, and social dynamics of individual leatherback sea turtles in ways or to a degree that would reduce their fitness. An action that is not likely to reduce the fitness of individual turtles would not be likely to reduce the viability of the populations those individual turtles represent (that is, we would not expect reductions in the reproduction, numbers, or distribution of those populations).

7.1.3.4 ***Loggerhead Sea Turtle***

Based on our risk analysis on annual and non-annual training activities, we conclude that in any given year during the five-year period (November 2013-November 2018), unspecified numbers of leatherback sea turtles could potentially experience take in the form of behavioral harassment resulting from non-impulsive acoustic stressors; however, behavioral responses of turtles to acoustic stressors is poorly studied and very difficult to quantify. Therefore, we do not specify the amount or extent of take in the form of behavioral harassment. We anticipate no more than 16,812 takes per year in the form of harassment from temporary threshold shifts (TTS) resulting from impulsive (188 instances) and non-impulsive (16,624 instances) sound stressors. We anticipate 34 takes in a given year or over the five-year period in the form of injury from impulsive (18 instances) and non-impulsive (16 instances) from permanent threshold shift (PTS). We also estimate approximately seven (7) injuries in the form of GI tract or lung injury during annual or non-annual training activities and four (4) mortalities from acoustic stressors could occur in a given year. While the potential for serious injury and mortality of sea turtles from vessel strike exists, it is very difficult to estimate the number and species composition of turtles that could be taken in the AFTT Study Area in transit zones and range complexes. Therefore, we do not quantify the amount or extent of take for the North Atlantic DPS of loggerhead sea turtles from vessel strike.

During testing activities, loggerhead sea turtles could potentially experience take in the form of behavioral harassment resulting from non-impulsive acoustic stressors; however, behavioral responses of turtles to acoustic stressors is poorly studied and very difficult to quantify. Therefore, we do not specify the amount or extent of take in the form of behavioral harassment. We anticipate no more than 1,017 takes per year in the form of harassment from temporary threshold shifts (TTS) resulting from impulsive (213 instances) and non-impulsive (804 instances) sound stressors. We anticipate 15 takes in a given year or over the five-year period in the form of injury from permanent threshold shift (PTS). We also estimate approximately 578 injuries in the form of GI tract or lung injury during annual or non-annual testing activities and 81 mortalities from impulsive acoustic stressors could occur in a given year. While the potential for serious injury and mortality of sea turtles from vessel strike exists, it is very difficult to estimate the number and species composition of turtles that could be taken in the AFTT Study Area in transit zones and range complexes. Therefore, we do not quantify the amount or extent of take for the North Atlantic DPS of loggerhead sea turtles from vessel strike.

Based on the evidence available, including the environmental baseline and cumulative effects, we conclude that impulsive acoustic stressors and vessel strike resulting from training exercises and testing activities the U.S. Navy plans to conduct in the AFTT Study Area on an annual basis, or cumulatively over the five year period from November 2013 through November 2018, or cumulatively for the reasonably foreseeable future (assuming there are no significant changes to the status of the species or Environmental Baseline), are not likely to adversely affect the population dynamics, behavioral ecology, and social dynamics of individual loggerhead sea turtles in ways or to a degree that would reduce their fitness. An action that is not likely to reduce the fitness of individual turtles would not be likely to reduce the viability of the populations those individual turtles represent (that is, we would not expect reductions in the reproduction, numbers, or distribution of those populations).

7.1.4 **Fish**

Stressors from testing and training activities vary in intensity, frequency, duration, and location within the AFTT Study Area. Based on the general threats to marine fish and the potential exposure and responses to stressors applicable to marine fish in the study area, we conclude that the following stressors are likely to result in take of ESA-listed, fish species:

- Acoustic (explosives and other impulsive acoustic sources), and
- Physical disturbance and strikes by vessels

Specific impacts to species are summarized in the following sections.

7.1.4.1 ***Smalltooth Sawfish***

The U.S. Navy determined that stressors resulting from explosives may affect, and are likely to adversely affect smalltooth sawfish by imposing fitness consequences on an individual that could result in “take.” In addition, stressors resulting from sonar and other active acoustic sources, swimmer defense airguns, weapons firing/launch/impact noise, aircraft noise, vessel noise, electromagnetic devices, vessels and in-water devices, military expended materials, and seafloor devices may affect, but are not likely to adversely affect smalltooth sawfish by imposing fitness consequences on an individual that could result in "take." All other stressors were determined to have "no effect" on smalltooth sawfish since exposure or response to these potential stressors would not be expected.

While the potential for take of very small numbers of smalltooth sawfish in the form of injury and/or mortality from impulsive acoustic stressors and vessel strike exists especially over longer periods of time, we are unable to quantify the amount or extent of injury or mortality that might occur due to lack of information on location and abundance of smalltooth sawfish during training and testing activities.

Based on the evidence available, including the environmental baseline and cumulative effects and despite our inability to quantify the amount or extent of take, we conclude that impulsive and non-impulsive acoustic stressors resulting from training exercises and testing activities the U.S. Navy plans to conduct in the AFTT Study Area on an annual basis, or cumulatively over the five year period from November 2013 through November 2018, or cumulatively for the reasonably foreseeable future (assuming there are no significant changes to the status of the species or Environmental Baseline), are not likely to adversely affect the population dynamics, behavioral ecology, and social dynamics of individual smalltooth sawfish in ways or to a degree that would reduce their fitness. An action that is not likely to reduce the fitness of individuals would not be likely to reduce the viability of the populations those individual smalltooth sawfish represent (that is, we would not expect reductions in the reproduction, numbers, or distribution of those populations).

7.1.4.2 *Gulf Sturgeon*

We do not anticipate take of Gulf sturgeon in the form of behavioral harassment or injury as a result of exposure to acoustic stressors during training or testing. While the potential for take of very small numbers of sturgeon in the form of injury and/or mortality from impulsive acoustic stressors and vessel strike exists especially over longer periods of time, we are unable to quantify the amount or extent of injury or mortality that might occur due to lack of information on location and abundance of sturgeon during testing and training activities.

Based on the evidence available, including the environmental baseline and cumulative effects and despite our inability to quantify the amount or extent of take, we conclude that impulsive and non-impulsive acoustic stressors resulting from training exercises and testing activities the U.S. Navy plans to conduct in the AFTT Study Area on an annual basis, or cumulatively over the five year period from November 2013 through November 2018, or cumulatively for the reasonably foreseeable future (assuming there are no significant changes to the status of the species or Environmental Baseline), are not likely to adversely affect the population dynamics, behavioral ecology, and social dynamics of individual Gulf sturgeon in ways or to a degree that would reduce their fitness. An action that is not likely to reduce the fitness of individual sturgeon would not be likely to reduce the viability of the populations those individual sturgeon represent (that is, we would not expect reductions in the reproduction, numbers, or distribution of those populations).

7.1.4.3 *Atlantic Sturgeon*

We do not anticipate take of Atlantic sturgeon in the form of behavioral harassment or injury as a result of exposure to non-impulsive acoustic stressors during training or testing. Encounters with impulsive acoustic stressors such as explosions may result in behavioral responses, hearing loss, physical injury, or death to fish near the activity. While the potential for take of very small numbers of sturgeon in the form of injury and/or mortality from vessel strike exists especially over longer periods of time, we are unable to quantify the amount or extent of injury or mortality that might occur due to lack of information on location and abundance of Atlantic sturgeon during testing and training activities.

Based on the evidence available, including the environmental baseline and cumulative effects and despite our inability to quantify the amount or extent of take, we conclude that impulsive and non-impulsive acoustic stressors resulting from training exercises and testing activities the U.S. Navy plans to conduct in the AFTT Study Area on an annual basis, or cumulatively over the five year period from November 2013 through November 2018, or for the reasonably foreseeable future (assuming there are no significant changes to the status of the species or Environmental Baseline), are not likely to adversely affect the population dynamics, behavioral ecology, and social dynamics of individual Atlantic sturgeon in ways or to a degree that would reduce their fitness. An action that is not likely to reduce the fitness of individual sturgeon would not be likely to reduce the viability of the populations those individual sturgeon represent (that is, we would not expect reductions in the reproduction, numbers, or distribution of those populations).

8 CONCLUSION

During the consultation, we reviewed the current status of endangered blue whales, fin whales, humpback whales, North Atlantic right whales, sei whales, sperm whales, the Arctic DPS of ringed seals, threatened green sea turtles, endangered hawksbill sea turtles, endangered leatherback sea turtles, endangered Kemp's ridley sea turtles, the threatened Northwest Atlantic Distinct Population Segment of loggerhead sea turtles, Gulf sturgeon, Atlantic sturgeon and smalltooth sawfish. We also assessed the environmental baseline for the AFTT action area including ongoing U.S. Navy training and testing in the AFTT Study Area along with the potential effects of U.S. Navy proposed Atlantic Fleet Training and Testing Study from November 2013 through November 2018 along with the National Marine Fisheries Service's Permit Division's proposed rule on the take of marine mammals incidental to training and testing activities.

Based on our consideration of potential cumulative impacts in the sense of NEPA (see Section 3.6 of this Opinion), we concluded that one of the three primary stressors (the probability of a ship strike) accumulated in the sense that the probabilities of collisions associated with multiple transits are higher than the probabilities associated with a single transit. We factored those considerations into our estimation of the probability of a collision associated with multiple transits.

Otherwise, we concluded that two of the three primary stressors associated with the U.S. Navy training (active sonar and underwater detonations) do not accumulate in either of the two senses of cumulative impacts we discussed in Section 3.6. Specifically, we concluded that the effects of multiple exposures to active sonar or underwater detonations were not likely to accumulate through altered energy budgets caused by avoidance behavior (reducing the amount of time available to forage), physiological stress responses (mobilizing glucocorticosteroids, which increases an animal's energy demand), or the canonical costs of changing behavioral states (small decrements in the current and expected reproductive success of individuals exposed to the stressors). In particular, we concluded that the species would be exposed on foraging areas and would experience trivial increases in feeding duration, effectiveness, or both, that would not accumulate in a manner that is likely to result in avoidance behavior or altered energy budgets. In short, the vast majority of impacts expected from sonar exposure and underwater detonations are behavioral in nature, temporary and comparatively short in duration, relatively infrequent, and not of the type or severity that would be expected to be additive for the stocks and species likely to be exposed either annually, over the five-year duration of the MMPA regulations, or into the reasonably foreseeable future as these training and testing activities are expected to continue.

Thus, while the number of individuals "taken" gets larger over time, the effect of each "take" on the survival or reproductive success of the animals themselves would not accumulate in the same way. As a result, for example, we do not expect that instances of exposing whales to mid-frequency active sonar in a single year, or instances of exposing them to active sonar over five years or into the reasonably foreseeable future, would result in effects that would be greater than what we would expect from a single exposure event. To the contrary, we did not expect the effects of that "take" to have any additive, interactive, or synergistic effect on the individual animals, the population(s) those individuals represent, or the species those population(s) comprise. With respect to threatened and endangered marine mammals, our conclusion that the aggregate number of exposures over the five-year duration of the MMPA regulations or and into the reasonably foreseeable future is unlikely to result in accumulated adverse impacts is also supported by the negligible impact determination and response to comments contained in the MMPA rulemaking as well as the Navy's FEIS/OEIS.

Therefore, it is NMFS' opinion that these training and testing activities are likely to adversely affect but are not likely to jeopardize the continued existence of these threatened and endangered species under NMFS' jurisdiction and are not likely to result in the destruction or adverse modification of critical habitat that has been designated for endangered or threatened species in the AFTT action area during the 5-year period or in the reasonably foreseeable future past the 5-year period, assuming that the type, amount and extent of training and testing do not exceed levels assessed in this opinion and/or the status of the species affected by these actions does not change significantly from that assessed in this Opinion.

This opinion also concludes that the NMFS' issuance of the rule and two letters of authorization (LOAs) pursuant to the proposed MMPA rule as assessed in this Opinion for respective training and testing activities to take marine mammals for a period beginning in November 2013 and ending in November 2018, incidental to the U.S. Navy's testing and training activities are likely to adversely affect but are not likely to jeopardize the continued existence of these threatened and endangered species under NMFS' jurisdiction and are not likely to result in the destruction or adverse modification of critical habitat that has been designated for endangered or threatened species in the AFTT action area.

9 Incidental Take Statement

Section 9 of the ESA and Federal regulation pursuant to section 4(d) of the ESA prohibit the take of endangered and threatened species, respectively, without special exemption. Take is defined as to harass, harm, pursue, hunt, shoot, wound, kill, trap, capture or collect, or to attempt to engage in any such conduct. Harm is further defined by NMFS to include significant habitat modification or degradation that results in death or injury to listed species by significantly impairing essential behavioral patterns, including breeding, feeding, or sheltering. Incidental take is defined as take that is incidental to, and not the purpose of, the carrying out of an otherwise lawful activity. Under the Marine Mammal Protection Act, there is a definition of what is referred to as Level B harassment: "any act of pursuit, torment, or annoyance which . . . has the potential to disturb a marine mammal or marine mammal stock in the wild by causing disruption of behavioral patterns, including, but not limited to, migration, breathing, nursing, breeding, feeding, or sheltering but which does not have the potential to injure a marine mammal or marine mammal stock in the wild" 16 U.S.C. §1362(18)(A)(ii). For this consultation, we interpret "harass" using the MMPA definition to marine mammals. For other species, specifically sea turtles, we apply "harass" to mean an intentional or negligent action that has the potential to injure an animal or disrupt its normal behavior to a point where such behaviors are abandoned or significantly altered. Section 7(b)(4) and section 7(o)(2) provide that taking that is incidental to an otherwise lawful agency action is not considered to be prohibited taking under the ESA if that action is performed in compliance with the terms and conditions of this incidental take statement.

9.1 Amount or Extent of Take

The section 7 regulations require NMFS to specify the impact of any incidental take of endangered or threatened species; that is, the amount or extent, of such incidental taking on the species (50 CFR §402.14(i)(1)(i)). The amount of take represents the number of individuals that are expected to be taken by proposed actions while the extent of take or "the extent of land or marine area that may be affected by an action" if we cannot assign numerical limits for animals that could be incidentally taken during the course of an action (51 FR 19953). The amount of take resulting from the Navy's activities was estimated based on the best information available. Where we could quantify take, the numeric estimates involve many assumptions and a level of uncertainty remains. Additionally, with the limitations of modeling for marine mammals and sea turtles and limited information on population densities and locations for all species, it is very difficult to simulate real-world scenarios and possible interactions of cetaceans, pinnipeds, sea turtles and fish during actual training and testing activities.

9.1.1 Take Incidental to Atlantic Fleet Training Exercises and Issuance of the MMPA Rule and Letters of Authorization

In the following sections we summarize the anticipated take from annual and non-annual training exercises by species as proposed by the Navy and the interrelated and interdependent actions of issuance of a five-year regulation and LOAs by NMFS' Permits Division to authorize take of marine mammals pursuant to the MMPA.

Section 7(b)(4)(C) of the ESA provides that if an endangered or threatened marine mammal is involved, the taking must first be authorized by Section 101(a)(5) of the MMPA. Accordingly, the terms of this incidental take statement and the exemption from Section 9 of the ESA become effective only upon the issuance of MMPA authorization to take the marine mammals identified here. Absent such authorization, this statement is inoperative for marine mammals. The amount or extent of incidental take for marine mammals will be exempted upon issuance of the LOAs.

Table 150 provides the anticipated take incidental to annual and non-annual traiing activities in a given year where all possible activities are carried out in that year. For marine mammals, we provide a total for the five-year period including the annual take and take from non-annual training (not occurring every year). As such, take from non-annual activities would be less than the sum of the total of each year given a scenario where all annual and all non-annual activities take place in that year. Where the five-year total would be the same as the totaling the annual potential take, the amount of take is provided per year.

The estimation or unspecified amounts of take below are directly linked to the levels of training activities described in the description of the action and in our risk analysis. Therefore, these training levels (location, frequency, duration, timing, etc.) also serve as an indicator of take. For example, if hours of a specific activities or categories of activities assessed are exceeded, the quantitative or qualitative take estimates may also be exceeded.

Table 150. Take Authorized Incidental to Annual and Non-annual Training Exercises, Issuance of the MMPA Regulation and Issuance of the LOAs

ESA-Listed Species	Annual and Non-Annual Training Exercises				
	Acoustic Stressors				Vessel Strike
	Harass (Behavioral & Temporary Threshold Shift)	Harm (PTS)	Harm (GI Tract, Slight Lung Injury, Other)	Mortality	Injury or Mortality
Cetaceans (Mysticetes)					
North Atlantic Right Whale	Up to 112 per year; Not to exceed 560 total in 5 years	0	0	0	0

Humpback Whale	Up to 1,643 per year; Not to exceed 8,215 total in 5 years	1/yr.	0	0	3 of any species (excluding North Atlantic right whale) per year; Not to exceed 10 of any combination of species in 5 years
Sei Whale	Up to 10,188 per year; Not to exceed 50,940 total in 5 years	1/yr.	0	0	
Fin Whale	Up to 4,490 per year; Not to exceed 22,450 total in 5 years	1/yr.	0	0	
Blue Whale	Up to 147 per year; Not to exceed 735 total in 5 years	0	0	0	
Cetaceans (Odontocetes)					
Sperm Whale	Up to 14,749 per year; Not to exceed 73,743 total in 5 years	0	0	0	
Pinnipeds					
Ringed Seal-Arctic DPS	0	0	0	0	0
Sea Turtles					
Hardshell Sea Turtles[1]	12,216 per year*	22/yr.	4/yr.	2/yr.	**
Kemp's Ridley Sea Turtle	302 per year*	2/yr.	1/yr.	1/yr.	**
Leatherback Sea Turtle	8,909 per year*	23/yr.	2/yr.	1/yr.	**
Loggerhead Sea Turtle	16,812 per year*	34/yr.	7/yr.	4/yr.	**
Fish					
Smalltooth Sawfish	*	-	-	***	-
Gulf Sturgeon	*	-	-	***	-
Atlantic Sturgeon	*	-	-	***	-

[1] The hardshell sea turtles category including hawksbill, green, Kemp's ridley, and loggerhead sea turtles addresses take where specific take by species cannot be quantified.
NOTE: Non-annual events, those events that may only take place a few times over the five-year period and do not reoccur every year; take from non-annual activities is included with annual take to represent a maximium potential take in any given year.
***Behavioral responses of fish and sea turtles to impulsive and non-impulsive sound stressors is not well studied and cannot be quantified in this opinion. This number for turtles includes only modeled TTS but does not exclude associated behavioral responses that could occur. Take from behavioral disturbance will be exceeded if activity levels as proposed are exceeded.**
**** Unspecified Number. While the potential for serious injury and mortality of sea turtles from vessel strike exists, it is very difficult to estimate the number and species composition of turtles that could be "taken" in the AFTT Study Area in transit zones and range complexes. Take will be exceeded if activity levels as proposed are exceeded.**
***** Unspecified Number. While the potential for mortality of smalltooth sawfish, Gulf sturgeon and Atlantic sturgeon from explosions (impulsive sound) is very low in any given year, the potential for inury leading to mortality to occur over a longer period exists but cannot be quantified due to the lack of information on**

sturgeon locations during training exercises especially in shallow coastal waters. Take will be exceeded if activity levels as proposed are exceeded.

9.1.2 Take Incidental to Atlantic Fleet Testing Activities and Issuance of the MMPA Rule and Letters of Authorization

In the following sections we summarize the anticipated take from annual and non-annual testing activities by species as proposed by the Navy and the interrelated and interdependent actions of issuance of a five-year regulation and LOAs by NMFS' Permits Division to authorize take of marine mammals pursuant to the MMPA.

"Section 7(b)(4)(C) of the ESA provides that if an endangered or threatened marine mammal is involved, the taking must first be authorized by Section 101(a)(5) of the MMPA. Accordingly, the terms of this incidental take statement and the exemption from Section 9 of the ESA become effective only upon the issuance of MMPA authorization to take the marine mammals identified here. Absent such authorization, this statement is inoperative for marine mammals. The amount or extent of incidental take for marine mammals will be exempted upon issuance of the LOAs.

Table 151 provides the the maximum (annual + non-annual testing) anticipated incidental take in a given year where all possible testing activities are carried out in that year. For marine mammals, we provide a maximum for the five-year period that reflects the frequency of non-annual testing activities which would be less than the total of the maximum in a year given a scenario where all annual and all non-annual activities take place in that year. Where the five-year total would be the same as the totaling the annual maximum potential take, the amount of take is provided per year.

The estimation or unspecified amounts of take below are directly linked to the levels of testing activities described in the description of the action and in our risk analysis. Therefore, these training levels (location, frequency, duration, timing, etc.) also serve as an indicator of take. For example, if hours of a specific activities or categories of activities assessed are exceeded, the quantitative or qualitative take estimates may also be exceeded.

Table 151. Take Authorized Incidental to Annual and Non-annual Testing Exercises, Issuance of the MMPA Regulation and Issuance of the LOAs

ESA-Listed Species	Annual and Non-Annual Testing Activities				
	Acoustic Stressors				Vessel Strike
	Harass (Behavioral & Temporary Threshold Shift)	Harm (PTS)	Harm (GI Tract, Slight Lung Injury, Other)	Mortality	Injury or Mortality
Cetaceans (Mysticetes)					
North Atlantic Right Whale	Up to 87 per year; Not to exceed 395 total in 5 years	0	0	0	0

Humpback Whale	Up to 200 per year; Not to exceed 976 total in 5 years	0	0	0	1 of any whale species (excluding North Atlantic right whale) per year; not to exceed 1 of any combination of species in 5 years
Sei Whale	Up to 796 per year; Not to exceed 3,821 total in 5 years	0	0	0	
Fin Whale	Up to 599 per year; Not to exceed 2,784 total in 5 years	0	0	0	
Blue Whale	Up to 18 per year; Not to exceed 82 total in 5 years	0	0	0	
Cetaceans (Odontocetes)					
Sperm Whale	Up to 1,786 per year; Not to exceed 8,533 total in 5 years	0	5/yr.(I) Not to exceed 6 total in 5 years	0	
Pinnipeds					
Ringed Seal-Arctic DPS	Up to 359 per year; Not to exceed 1,795 total in 5 years	0	0	0	-
Sea Turtles					
Hardshell Sea Turtles[1]	5,132 per year*	10/yr.	242/yr.	49/yr.	**
Kemp's Ridley Sea Turtle	292 per year*	0	17/yr.	4/yr.	**
Leatherback Sea Turtle	6,362 per year*	29/yr.	162/yr.	57/yr.	**
Loggerhead Sea Turtle	1,017 per year*	15/yr.	578/yr.	81/yr.	**
Fish					
Smalltooth Sawfish	*	-	-	***	-
Gulf Sturgeon	*	-	-	***	-
Atlantic Sturgeon	*	-	-	***	-

[1] The hardshell sea turtles category including hawksbill, green, Kemp's ridley, and loggerhead sea turtles
NOTE: Non-annual events, those events that may only take place a few times over the five-year period and do not reoccur every year; take from non-annual activities is included with annual take to represent a maximium potential take in any given year.
***Behavioral responses of sea turtles and fish to impulsive and non-impulsive sound stressors is not well studied and cannot be quantified in this opinion. This number for turtles includes only modeled TTS but does not exclude associated behavioral responses that could occur. Take from behavioral disturbance will be exceeded if activity levels as proposed are exceeded.**

**** Unspecified Number. While the potential for serious injury and mortality of sea turtles from vessel strike exists, it is very difficult to estimate the number and species composition of turtles that could be "taken" in the AFTT Study Area in transit zones and testing and training range complexes. Take will be exceeded if activity levels as proposed are exceeded.**

***** Unspecified Number. While the potential for mortality of smalltooth sawfish, Gulf sturgeon and Atlantic sturgeon from explosions (impulsive sound) is very low in any given year, the potential for inury leading to mortality to occur over a longer period exists but cannot be quantified due to the lack of information on sturgeon locations during testing activities especially in shallow coastal waters. Take will be exceeded if activity levels as proposed are exceeded.**

9.2 Effects of the Take

In this biological opinion on proposed training and testing in the AFTT Study Area, we determined that individual blue, fin, humpback, sei, North Atlantic right, and sperm whales, as well as individual ringed seal, Arctic DPS, undetermined hard shell sea turtles, Kemp's ridley, leatherback, and loggerhead sea turtles, Gulf and Atlantic sturgeon and smalltooth sawfish might be exposed to non-impulsive acoustic stressors including active sonar and/or impulsive acoustic stressors such as explosions associated with the training exercises, testing, and other activities. Large whale, sturgeon and sea turtles may also be exposued to vessel strike. These individuals are likely to respond to those exposures in ways that NMFS would classify as "take." We subsequently determined that the amount or extent of take incidental to ongoing training and testing activities that is anticipated in a given year, or over the five-year period of the MMPA regulations and LOAs, or in the reasonably foreseeable future (assuming the *Environmental Baseline*, *Status of the Species*, and the proposed actions do not change significantly) is not likely to jeopardize the continued existence of these species or to destroy or adversely modify designated critical habitat.

Although the biological significance of the animal's behavioral responses largely remains unknown, exposure to active sonar transmissions could disrupt one or more behavioral patterns that are essential to an individual animal's life history or to the animal's contribution to a population. For the proposed action, behavioral responses that result from active sonar transmissions and any associated disruptions are expected to be temporary and would not affect the reproduction, survival, or recovery of these species.

The instances of harassment identified in Table 150 and Table 151 would generally represent changes from resting, milling, or other behavioral states that require lower energy expenditures to traveling, avoidance, or other behavioral states that require higher energy expenditures and, therefore, would represent significant disruptions of the normal behavioral patterns of the animals that have been exposed.

We grouped responses to active sonar and responses to vessel traffic and other environmental cues associated with the training exercises and testing activities because we assume animals would respond to a suite of environmental cues that include sound fields produced by active sonar, sounds produced by explosives, sounds produced by the engines of surface vessels, sounds produced by displacement hulls, and other sounds associated with training exercises and testing activities. That is, we assume endangered marine mammals will perceive and respond to all of the environmental cues associated with training and testing rather than the single stimulus represented by active sonar. Further, we assume endangered marine mammals would recognize cues that suggest that ships are moving away from them rather than approaching them and they would respond differently to both situations.

Harm of sea turtles would be in the form of permanent threashold shift or slight lung injury. Sea turtles that experience a permanent loss of hearing would not be expected to have a reduction in survival or reproductive potential. However, sea turtles that experience even a slight lung injury may not recover from such injury and would be expected to die as a result of that injury. In addition to the mortality from slight lung injury, a maximum of 191 sea turtles would be killed each year as a result of underwater explosions from annual or non-annual testing activities. An unknown number of sea turtles may also be struck by vessels.

While the loss of any turtle from injury or direct mortality from underwater explosions or vessel strike, including eggs, has likely adversely affected the ability of the sea turtle populations considered in this Opinion to maintain or increase their numbers by limiting the number of individuals in these populations, the loss of reproductive adults results in reductions in future reproductive output. Species with delayed maturity such as sea turtles are demographically vulnerable to increases in mortality, particularly of juveniles and subadults, those stages with higher reproductive value. The potential for an egg to develop into a hatchling, into a juvenile, and finally into a sexually mature adult sea turtle varies among species, populations, and the degree of threats faced during each life stage. Each juvenile that does not survive to reproduce will be unable to contribute to the maintenance or improvement of the species' status. Reproducing females that are prematurely killed due the threats mentioned in the above sections, while possibly having contributed something before being removed from the population, will not be allowed to realize their reproductive potential. Similarly, reproductive males prematurely removed from the population will be unable to make their reproductive contribution to the species' population.

9.3 Reasonable and Prudent Measures

The following reasonable and prudent measures are necessary and appropriate to minimize impacts of incidental take of the species listed in Table 150 and Table 151 in the incidental take statement of this biological opinion.

- The U.S. Navy and NMFS' Permits Division shall have measures in place to limit the potential for interactions with ESA-listed species as a result of the proposed actions described in this Opinion. Standards and procedures should be incorporated into policy and guidance, directives, and standard operating procedures as appropriate.

- The U.S. Navy and NMFS' Permits Division shall report all interactions with any ESA-listed species (marine mammals, fish and sea turtles) resulting from the proposed actions that are observed during the course of implementing monitoring requirements for marine mammals as required by LOAs.

9.3.1 Terms and Conditions

In order to be exempt from the prohibitions of section 9 of the ESA, the U.S. Navy and NMFS' Permits Division must comply with the following terms and conditions, which implement the reasonable and prudent measures described above and outline required reporting and monitoring requirements. These terms and conditions are nondiscretionary:

1. NMFS' Permits Division shall ensure that all mitigation and monitoring measures as proposed in the draft final rule in Section 2.4.1 of this biological opinion are implemented by the U.S. Navy through the issuance of a final rule and subsequent letters of authorization (LOA) pursuant to the Marine Mammal Protection Act.

The U.S. Navy and NMFS' Permits Division shall compile and summarize annual monitoring and exercise reports and describe interactions with ESA-listed species and designated critical habitat.

10 Conservation Recommendations

Section 7(a)(1) of the ESA directs Federal agencies including the U.S. Navy and NMFS to utilize their authority to further the purposes of the ESA by carrying out conservation programs for the benefit of endangered and threatened species. Conservation recommendations are discretionary agency activities to minimize or avoid adverse effects of a proposed action on listed species or critical habitat to help implement recovery plans or to develop information.

1. Collect sighting and stranding data for ESA-listed marine mammals, sea turtles, smalltooth sawfish and Atlantic sturgeon in the AFTT Study Area.
2. As practicable, develop procedures aid any individuals of an ESA-listed species that has been impacted by U.S. Navy training and testing activities and is in a condition requiring assistance to increase likelihood of survival.
3. Continue to model potential impacts to ESA-listed species using NAEMO and other relevant models; validate assumptions used in risk analyses; and seek new information and higher quality data for use in such efforts.
4. Continue technical assistance/adaptive management efforts with NMFS to help inform future consultations on U.S. Navy training and testing in the AFTT Study Area.

In order for NMFS to be kept informed of actions minimizing or avoiding adverse effects or benefitting listed species or their habitats, NMFS requests notification of the implementation of any conservation recommendations.

11 Reinitiation of Consultation

This concludes formal consultation on proposed Atlantic Fleet Training and Testing activities the U.S. Navy will conduct from November 2013 through November 2018. As provided in 50 CFR §402.16, reinitiation of formal consultation is required where discretionary Federal agency involvement or control over the action has been retained (or is authorized by law) and if: (1) the amount or extent of incidental take is exceeded; (2) new information reveals effects of the agency action that may affect listed species or critical habitat in a manner or to an extent not considered in this opinion; (3) the agency action is subsequently modified in a manner that causes an effect to the listed species or critical habitat not considered in this opinion; or (4) a new species is listed or critical habitat designated that may be affected by the action. In instances where the amount or extent of incidental take is exceeded, the U.S. Navy and NMFS' Permits Division must contact the ESA Interagency Cooperation Division, Office of Protected Resources immediately.

12 Data Quality Act

Section 515 of the Treasury and General Government Appropriations Act for Fiscal Year 2001 (Public Law 106-554, AKA the Data Quality Act or Information Quality Act) directed the Office of Management and Budget (OMB) to issue government-wide guidelines that "provide policy and procedural guidance to federal agencies for ensuring and maximizing the quality, objectivity, utility, and integrity of information (including statistical information) disseminated by federal agencies." OMB complied by issuing guidelines which direct each federal agency to 1) issue its own guidelines; 2) establish administrative mechanisms allowing affected persons to seek and obtain correction of information that does not comply with the OMB 515 Guidelines or the agency guidelines; and 3) report periodically to OMB on the number and nature of complaints received by the agency and how the complaints were handled. The OMB Guidelines can be found at:

http://www.whitehouse.gov/omb/fedreg/reproducible2.pdf

The Department of Commerce Guidelines can be found at:
http://ocio.os.doc.gov/ITPolicyandPrograms/Information_Quality/index.htm

The NOAA Section 515 Information Quality Guidelines, created with input and reviews from each of the components of NOAA Fisheries, went into effect on October 1, 2002. The NOAA Information Quality Guidelines are posted on the NOAA Office of the Chief Information Officer Webpage. http://www.cio.noaa.gov/Policy_Programs/info_quality.html

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