UNITED STATES DEPARTMENT OF COMMERCE
National Oceanic and Atmospheric Administration
NATIONAL MARINE FISHERIES SERVICE
Silver Spring, MD 20910

JUN 1 2011

Mr. Joseph Murphy,
SES USFF N4
1562 Mitscher Ave., Suite 250
Norfolk, VA 23551-2487
Dear Rear Admiral Cullom:

Enclosed are the National Marine Fisheries Service's (NMFS') biological and conference opinions (Opinions), issued under the authority of section 7(a)(2) and 7(a)(4) of the Endangered Species Act (ESA) on NMFS' Permits, Education and Conservation Division's proposed issuance of Letters of Authorization (LOAs) for the U.S. Navy to "take" marine mammals incidental to the conduct of military readiness activities on the Virginia Capes, Cherry Point, and Jacksonville Range Complexes from June 2011 to June 2012.

The Opinions concludes that the military readiness activities the U.S. Navy proposes to conduct on these range complexes are likely to adversely affect several species of endangered or threatened whales and sea turtles and the proposed Northwest Atlantic Distinct Population Segment (DPS) of loggerhead sea turtles, but those activities are not likely to jeopardize the continued existence of these species. The proposed military readiness activities are not likely to adversely affect designated North Atlantic right whale critical habitat, and therefore, it will not be destroyed or adversely modified. Also, attached to the biological opinion is an incidental take statement that exempts the "take" of endangered or threatened whales and sea turtles incidental to military readiness activities conducted on the Virginia Capes, Cherry Point, and Jacksonville Range Complexes from June 2011 to June 2012.

This concludes formal consultation and conference on the proposed military readiness activities conducted on the Virginia Capes, Cherry Point, and Jacksonville Range Complexes from June 2011 to June 2012. Reinitiation of formal consultation on the proposed activities is required where the U.S. Navy and NMFS retain discretionary involvement or control over the action 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, Action Agencies are required to reinitiate section 7 consultation immediately.

The U.S. Navy in conjunction with NMFS' Permits, Education, and Conservation Division may ask NMFS' Endangered Species Division to confirm the conference opinion as a biological opinion issued through formal consultation if the Northwest Atlantic DPS of loggerhead sea turtles is listed. The request must be in writing. If NMFS' Endangered Species Division reviews the proposed action and finds that there have been no significant changes in the action as planned or in the information used during the conference, NMFS' Endangered Species Division will confirm the conference opinion as the biological opinion and no further section 7 consultation will be necessary. After any final listing of the Northwest Atlantic DPS of loggerhead sea turtles and any subsequent adoption of this Conference Opinion, the U.S. Navy and NMFS' Permits, Education, and Conservation Division shall reinitiate consultation per the reinitiation criteria listed above for formal consultation.

If you have questions regarding the Opinions, please contact me or Angela Somma, Chief of our Endangered Species Division at (301) 713-1401.

Sincerely,

James H. Lecky
Director
Office of Protected Resources

NOAA's National Marine Fisheries Service

Endangered Species Act Section 7 Consultation

Biological and Conference Opinions

Agencies: United States Navy

Permits, Conservation and Education Division of the Office of Protected Resources, NOAA's National Marine Fisheries Service

Activities Considered: U.S. Navy activities in the Northeast Operating Areas from June 2011 to June 2012

U.S. Navy activities in the Virginia Capes Range Comple from June 2011 to June 2012

U.S. Navy activities in the Cherry Point Range Complex from June 2011 to June 2012

U.S. Navy activities in the Jacksonville Range Complex from June 2011 to June 2012

NMFS' 2011 Letters of Authorization for the U.S. Navy to "take" marine mammals incidental to the conduct of training in the Virginia Capes, Cherry Point and Jacksonvile Range Complexes June 2011 to June 2012

Consultation Conducted by: Endangered Species Division of the Office of Protected Resources, NOAA's National Marine Fisheries Service

Approved by: [signature]

Date: JUN 1 2011

Section 7(a)(2) of the Endangered Species Act (ESA) (16 U.S.C. 1531 et seq.) requires that each federal agency shall ensure that any action authorized, funded, or carried out by such agency 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 the action of a federal agency "may affect" a listed species or critical habitat that has been designated for such species, that agency is required to consult with either NOAA's National Marine Fisheries Service (NMFS) or the U.S. Fish and Wildlife Service (USFWS), depending upon the listed resources that may be affected.

Section 7(a)(4) of the ESA requires that each Federal agency shall confer with NMFS or USFWS, depending upon the listed resources that may be affected, on any agency action which is likely to jeopardize the continued existence of any species proposed to be listed or result in the destruction or adverse modification of critical habitat proposed to be designated for such species.

For the actions described in this document, the action agencies are the United States Navy, which proposes to undertake training activities in operating areas and range complexes along the Atlantic Coast of the United States of America and NMFS' Office of Protected Resources - Permits, Conservation, and Education Division (Permits Division), which proposes to issue Letters of Authorization (LOAs) that would authorize the U.S. Navy to "take" marine mammals incidental to those activities. The consulting agency for these proposals is NMFS' Office of Protected Resources - Endangered Species Division.

This document presents the results of section 7 consultations and conferences on several actions that are all proposed to occur along the Atlantic Coast of the United States: (1) the U.S. Navy's proposal to conduct training activities in (a) the Northeast Operating Area; (b) the Virginia Capes Range Complex; (c) the Cherry Point Range Complex; and (d) the Jacksonville Range Complex from June 2011 to June 2012; and (2) NMFS' Permits Division's proposal to issue annual LOAs to the U.S. Navy to "take" marine mammals incidental to the conduct of training in the Virginia Capes, Cherry Point, and Jacksonville Range Complexes for a one-year period beginning in June 2011 and ending in June 2012. NMFS' biological and conference opinions on each of these separate actions have been grouped into this single document because of their spatial proximity and their potential to result in cumulative impacts (in the NEPA sense of that term) on listed and proposed endangered and threatened species and designated critical habitat that occurs along the Atlantic Coast of the United States.

The biological and conference opinions (Opinions) have been prepared in accordance with section 7 of the ESA and are based on information provided in the applications for the proposed LOAs, published and unpublished scientific information on the biology and ecology of threatened and endangered whales, currently listed endangered and threatened sea turtles and proposed threatened sea turtles, Atlantic salmon, shortnose sturgeon and Atlantic sturgeon that occur along the Atlantic coast of the United States, and other sources of information which are discussed in greater detail in the *Approach to the Assessment* section of these Opinions.

Consultation History

On June 5, 2009, NMFS issued its programmatic biological opinion on U.S. Navy activities in the Northeast Operating Area and the Virginia Capes, Cherry Point and Jacksonville Range Complexes as well as the Permits Division's promulgation of regulations to authorization the Navy to "take" marine mammals incidental to those activities from June 2009 to June 2014. This programmatic opinion concluded that the activities the U.S. Navy proposed to conduct in those operating areas and range complexes were not likely to jeopardize endangered or threatened specis of whales and sea turtles. The programmatic opinion also concluded that critical habitat designated for North Atlantic right whales was not likely to be adversely affected by the Navy's activities, and therefore, would not be destroyed or adversely modified.

Also on June 5, 2009, NMFS issued its biological opinion on U.S. Navy activities in the Virginia Capes, Cherry Point and Jacksonville Range Complexes as well as the issuance of LOAs to the Navy to take marine mammals incidental to training activites on the three range complexes from June 2009 to June 2010. This opinion concluded that the activities the U.S. Navy proposed to conduct in those range complexes were not likely to jeopardize endangered or threatened species of whales and sea turtles. The opinion also concluded that critical habitat designated for North Atlantic right whales was not likely to be adversely affected by the Navy's activities, and therefore, would not be destroyed or adversely modified.

On June 3, 2010, NMFS issued its biological opinion on U.S. Navy activities in the Virginia Capes, Cherry Point and Jacksonville Range Complexes as well as the issuance of LOAs to the Navy to take marine mammals incidental to training activites on the three range complexes from June 2010 to June 2011. This opinion concluded that the activities the U.S. Navy proposed to conduct in those range complexes were not likely to jeopardize endangered or threatened specis of whales and sea turtles. The opinion also concluded that critical habitat designated for North Atlantic right whales was not likely to be adversely affected by the Navy's activities, and therefore, would not be destroyed or adversely modified.

On January 26, 2011, NMFS' Endangered Species Division received a request from the U.S. Navy for reinitiation of consultation as well as a conference for species proposed for listing since the last consultation and issuance of a biological opinion for their activites on the Virginia Capes, Cherry Point and Jacksonville Range Complexes from June 2011 to June 2012. This request for consultation and conference was accompanied by an addendum to their 2008 Biological Evaluation as amended in February 2009.

On May 3, 2011, NMFS' Permits Division requested reinitiation of consultation for their proposed issuance of LOAs to the Navy to take marine mammals incidental to training activites on the Virginia Capes, Cherry Point and Jacksonville Range Complexes from June 2011 to June 2012.

BIOLOGICAL AND CONFERENCE OPINIONS

1.0 Description of the Proposed Actions

This biological opinion considers several actions that have been proposed by the U.S. Navy and NMFS' Permits Division:

1. the U.S. Navy's proposal to continue to conduct training activities within and adjacent to: (a) waters off the Northeast coast of the United States, (b) the Virginia Capes Range Complex; (c) the Cherry Point Range Complex, and (d) the Jacksonville Range Complex. The purpose of the U.S. Navy's training activities is to meet the requirements of the U.S. Navy's Fleet Response Training Plan.

2. the Permits Division's proposal to issue annual letters of authorization to the U.S. Navy to "take" marine mammals incidental to training activites on the Virginia Capes Range Complex, Cherry Point Range Complex, and Jacksonville Range Complex over the 12-month period from June 2011 to June 2012 incidental to the U.S. Navy's training activities.

As described in the *Description of the Proposed Action* of NMFS' 2009 programmatic biological opinion, and subsequent biological opinions issued in 2009 and 2010, these documents continue to represent NMFS' biological opinions on each of these separate actions. Pursuant to the goals of the section 7 regulations (50 CFR 402.14(c)), NMFS' biological and conference opinions on each of these separate actions described herein are grouped into this single document because of their spatial proximity and their potential to result in cumulative impacts (in the NEPA sense of that term) on listed and proposed endangered and threatened species and designated critical habitat that occur along the Atlantic Coast of the United States. Section 7 consultations and conferences on subsequent LOAs or that result from reinitiating section 7 consultation on any one of the actions considered in this document may result in separate biological opinions and conference opinions as necessary in the future.

1.1 Training in Northeast Operating Areas

The U.S. Navy's Fleet Forces Command proposes to continue unit level training exercises during transits to, from, and within the Atlantic City Operating Area, Narragansett Bay Operating Area, and Boston Complex. Unit level training generally involves training activities by a single vessel in which the vessel uses only its own systems or sensors and includes man overboard drills, towed array operations (passive), small arms training, and surface gunnery (inert only). Unit level training activities are conducted at the discretion of the vessel Commanding Officer if and only if the proximity of surrounding traffic permits.

1.2 Training in the Virginia Capes Range Complex

In June 2009, NMFS issued a programmatic biological opinion that assessed the probable direct and indirect effects of the U.S. Navy's military readiness activities on the Virginia Capes Range Complex on endangered and threatened species and designated critical habitat that is likely to occur on or near that range complex. That Opinion concluded that several of the activities the U.S. Navy plans to conduct on the range complex are not likely to adversely affect listed species or designated critical habitat because (1) the activities are not likely to produce stimuli that would represent potential stressors for endangered or threatened species or designated critical habitat under NMFS' jurisdiction; (2) the activities are likely to produce stimuli that would represent potential stressors for endangered or threatened species or designated critical habitat under NMFS' jurisdiction, but those species or critical habitat are not likely to be exposed to stressors; or (3) endangered or threatened species or designated critical habitat under NMFS' jurisdiction are likely to be exposed to potential stressors associated with the activities, but they are not likely to respond given that exposure. Specifically, endangered or threatened species or designated critical habitat under NMFS' jurisdiction are not likely to be exposed to stressors associated with the following activities:

1. Test and Evaluation, which consists of shipboard electronic systems evaluation facility utilization (SESEF). These training operations could occur throughout the Virginia Capes Operating Area, although they are most likely to occur within SESEF ULM-4 Range and RCS Range. Our programmatic biological opinion concluded that these activities are not likely to directly or indirectly introduce potential stressors into the marine environment where endangered or threatened species under NMFS' jurisdiction might be exposed to those stressors. There are no changes to these training operations that would change the conclusions of the 2009 programmatic biological opinion.

2. AN/AES-1 Airborne Laser Mine Detection System is a non-towed (airborne) mine-hunting system designed to rapidly detect, classify, and locate near-surface floating or moored mines. A pod mounted on the MH-60S pylon contains the laser Light Detection and Ranging (LIDAR) system used to detect mines. An operator on the helicopter identifies potential mines from the laser images on a video monitor and marks their exact locations. A separate mine neutralization system is needed to disable or destroy mines once they have been identified. Our programmatic biological opinion concluded that these activities would introduce light associated with the LIDAR system into the marine environment, but endangered or threatened species under NMFS' jurisdiction are not likely to be aware of or respond to that light. There are no changes to these training operations that would change the conclusions of the 2009 programmatic biological opinion.

3. AN/AQS-20**,** which is a towed, mine-hunting system designed to detect, classify, and localize bottom and moored mines in deep or shallow water. An underwater, towed body attached to an MH-60S helicopter with an electromechanical cable that contains the high-frequency, high-resolution, side-looking, multi-beam sonar system. It can also be configured with an electro-optic identification sensor that incorporates a laser (LIDAR) system to identify bottom mines. An operator on the helicopter identifies potential mines from the sonar and laser images on a video monitor and marks their exact locations. A separate mine neutralization system is needed to disable or destroy mines once identified. Our programmatic biological opinion concluded that these activities would introduce light associated with the LIDAR system into the marine environment, but endangered or threatened species under NMFS' jurisdiction are not likely to be aware of or respond to that light. There are no changes to these training operations that would change the conclusions of the 2009 programmatic biological opinion.

4. Commercial Air Services Support for Fleet Training. In 2009 the Navy proposed to increase the number, type, and operation of commercial air services within the Virginia Capes Range Complex. Continuing to increase use of commercial air services to support Fleet training would not substantially increase aircraft numbers, emissions, or time spent in the warning areas, or alter current airspace usage. Rather, commercial air services would displace Fleet assets now used to support Fleet training events. Our programmatic biological opinion concluded that these activities are not likely to directly or indirectly introduce potential stressors into the marine environment where endangered or threatened species under NMFS' jurisdiction might be exposed to those stressors. There are no changes to these training operations that would change the conclusions of the 2009 programmatic biological opinion.

Because these activities are not likely to adversely affect endangered or threatened species under NMFS' jurisdiction, they will not be considered further in this document.

The following narratives summarize the remaining training operations the U.S. Navy plans to conduct on the Virginia Capes Range Complex. Table 1 at the end of this section identifies the specific training activities and number of events for each activity while Chapter 2 and Appendix D of the U.S. Environmental Impact Statement and Overseas Environmental Impact Statement on the Virginia Capes Range Complex provide more detailed narratives of these training operations and specific ordnance that might be involved in particular training operations (U.S. Navy 2008a).

1. MINE WARFARE, which would consist of mine countermeasures and mine neutralization training operations. The Navy proposes to increase underwater detonation training from 24 events using 20 lb net explosive weight charges to an annual total of 319 events. The 319 events include 9 events using 5 lb net explosive weight chares, 150 events using 10 lb net explosive weight charges and 160 events using 20 lb net explosive weight charges. These exercises are designed to train Navy personnel to detect, identify, classify, mark, avoid, and disable sea mines using a variety of methods. These training operations would generally occur within areas W-50A, W-50C (including the Surface Danger Zone), W-72, W-386, and the lower Chesapeake Bay training area (see Figure 1 at the end of this section).

2. SURFACE WARFARE, which would consist of bombing exercises (air-to-surface) involving F/A-18 and F-35 aircraft; missile exercises (air-to-surface); gunnery exercises (air-to-surface and surface-to-surface); laser targeting, and maritime security operations (including military interception operations and visit, board, search, and seizure operations). Air-to-surface missile exercises train aircrews to deliver missiles to surface targets, air-to-surface gunnery exercises train aircrews to attack surface targets with guns, surface-to-surface gunnery exercises train ship crews to attack surface targets with guns, and maritime security operations are designed to train Navy personnel to identify, track, intercept, board, and inspect surface vessels. The Navy proposes to increase air-to-surface BOMBEX training from 5 events to 10 events deploying a total of 40 bombs (4 bombs/event). Instead of the MK-83 (1,000 lb, 416 net explosive weight high explosive bomb), the Navy will use the smaller MK-82 (500 lb, 192 net explosive weight high explosive bomb) for these exercises. Bombing operations would generally occur within areas

W-386 (Air-K), W-72A (Air-3B), and W-72A/B. Some surface warfare training operations would occur in these same areas as well as within areas W-50C and R-6606. Maritime Security Operations and Maritime Interdiction Operations would occur throughout the Virginia Capes Operating Area.

3. AIR WARFARE, which would consist of air combat maneuvers, gunnery exercises (air-to-air) and missile exercises (air-to-air), gunnery exercises (surface-to-air), missile exercises (surface-to-air), air intercept control, and detect to engage. Air combat maneuvers, air-to-air gunnery exercises, and air-to-air missile exercises would generally occur within areas W-386 (Air-D, G, H, K), W-72A (Air-2A, Air-2B, Air-3A and Air-3B). Surface-to-air training operations would generally occur within areas W-386 and W-72, except for surface-to-air missile exercises, which would generally occur throughout the Virginia Capes Operating Area.

4. STRIKE WARFARE, which would consist of High-Speed Anti-Radiation (HARM) missile exercises (air-to-surface) and would generally occur within area W-386 (Air-E, F,I, and J). The U.S. Navy currently conducts about 26 sorties for a total of 26 missiles in the Virginia Capes Range Complex each year.

5. AMPHIBIOUS WARFARE, which would consist of Firing Exercises with Integrated Maritime Portable Acoustic Scoring and Simulation System (IMPASS) operations. These training operations would preferentially occur in areas W-386, 7C, 7D, 8C, 8D, W-72, IC1 and IC2 with W-386, 5C, and 5D as secondary areas. The U.S. Navy currently conducts about 22 of these firing exercise events, involving a total of 1,340 rounds, in the Virginia Capes Range Complex each year.

6. ELECTRONIC COMBAT, which would consist of chaff exercises, flare exercises, and electronic combat operations. These training operations would generally occur within areas W-72 and W-386, although some electronic combat operations would occur throughout the Virginia Capes Operating Area. The U.S. Navy currently conducts about 1,821 chaff exercise sorties and events, 63 flare exercise sorties, and 274 electronic combat operations sorties or events in the Virginia Capes Range Complex each year.

7. Research, Development, Test and Evaluation, which consists of operational test & evaluation, developmental test & evaluation, and production acceptance test & evaluation. Tests include a wide variety of aircraft, ships, ocean engineering, missile firings, torpedo testing, manned and unmanned submersibles, unmanned aerial and underwater vehicles, electronic warfare and other Navy weapons systems. Tests are used principally for equipment maintenance and to ensure that equipment within units work well when integrated.

The U.S. Navy also proposes to conduct Maritime Security Surge Surface Strike Group (Independent Deployment) Training in the Virginia Capes Range Complex. In addition, the U.S. Navy proposes to use the Virginia Capes Range Complex to prepare surface ships and embarked air, special forces and Marine Corps units for deployment as Maritime Security Surge Surface Strike Groups. Each fleet maintains a number of ships ready to deploy on short notice. Preparing a Maritime Security Surge Surface Strike

Group for deployment includes a mix of classroom, synthetic and live training events. Live training ensures proficiency in multi-unit procedures and autonomous operations by means of anticipated region-specific scenarios. The Navy does not expect Maritime Security Surge Surface Strike Group training to significantly alter the overall type and quantity of operations currently conducted in the Virginia Capes Range Complex.

Finally, the U.S. Navy proposes to provide range support and services at the Virginia Capes Range Complex that would be required to accommodate additional squadrons of aircraft and new systems and weapons that would be associated with changes in the structure of naval forces. The additional squadrons include:

8. MH-60S Multi-Mission Combat Support Helicopter missions, which would include organic mine ountermeasures, air-to-surface missile and gunnery operations, combat search and rescue, search and rescue, special operations, logistics support, surface warfare, maritime security operations, and chaff and flare exercises (electronic combat capability that supports all other mission areas).

Most operations of the MH-60S helicopter in the Virginia Capes Range Complex would involve a single aircraft engaged in unit-level training sorties less than two hours in duration that would begin and end at Naval Station Norfolk. When they participate in Carrier Strike Group exercises, these aircraft would deploy as an entire squadron; when they participate in Expeditionary Strike Group exercises, these aircraft would deploy in one- or-two helicopter detachments aboard frigates, destroyers, cruisers, and amphibious ships in support of an Expeditionary Strike Group. All of the training exercises involving these aircraft that were considered in this consultation would occur at sea.

9. MH-60R Multi-Mission Helicopter missions, which would include anti-submarine warfare, surface warfare, maritime security operations, and search and rescue. The Atlantic Fleet would split the projected 105 airframes between Naval Air Station Jacksonville and Naval Station Mayport (Florida), distributed between five carrier air wing squadrons, two expeditionary squadrons, and one Fleet replacement squadron.

Most MH-60R Unit-Level Training operations would occur in the Jacksonville Range Complex near their home bases. With few exceptions, the MH-60R would only train in the Virginia Capes Range Complex when they participate in major exercises. The deployment and training patterns for the MH-60R would resemble those discussed for the MH-60S (see preceding description) and would also include sonar training.

New systems and weapons the U.S. Navy would employ in the Virginia Capes Range Complex include:

10. The Organic Mine Countermeasures Systems. The Navy proposes to accommodate operations of MH-60S helicopters, surface ships, and submarines equipped with new Organic Mine Countermeasures

systems in the Virginia Capes Range Complex. This would entail some changes in tactics, techniques, and procedures from current mine warfare training. "Organic" refers to the concept of embedding mine warfare capability into the strike group rather than as an external capability of specialized ships and aircraft, only brought in on an as-needed basis. The Navy plans to configure 51 of the 102 MH-60Ss eventually home based at Naval Station Norfolk with Organic Mine Countermeasures capability. These systems include:

- Towed mine-hunting sonar (AN/AQS-20A);
- Towed magnetic influence and acoustic, mine-sweeping body (OASIS);
- Airborne mine-hunting laser (ALMDS);
- Submerged mine-neutralization, self-propelled devices using explosive charges (Airborne Mine Neutralization System); and
- Airborne, mine-neutralization ordnance (designated A/AWS-2 and abbreviated as RAMICS in Navy documents).

11. The Airborne Mine Neutralization System **(**designated AN/ASQ-235 and abbreviated as AMNS in Navy documents) is a non-towed system designed to identify and neutralize bottom and moored mines in the ocean environment. A hovering MH-60S or MH- 53E helicopter lowers an expendable, self-propelled, neutralizer device into the water at a safe distance from a potential mine previously identified with a separate mine-hunting system. A fiber-optic cable connected to the neutralizer relays depth, position, and sensor (sonar and video) information to the operator in the helicopter, who sends control and guidance commands back to the neutralizer. The operator guides the lightweight (15.5 kg) and highly maneuverable vehicle to the target location using onboard high frequency sonar. After the target is viewed and positively identified with an on-board video camera, the operator detonates a charge to neutralize the mine.

For training and testing purposes, the airborne mine neutralization system explosive charge can be replaced with a ballast device that would cause the neutralizer to float to the surface for recovery and reuse after completion of the exercise. Training targets are expendable, non-explosive, bottom and moored mine shapes. The Navy evaluated the potential environmental effects of testing airborne mine neutralization system and concluded that significant impacts would not occur (U.S. Navy 2001; 2002b).

12. The Rapid Airborne Mine Clearance System (designated A/AWS-2 and abbreviated as RAMICS in Navy documents) consists of a non-towed system designed to neutralize floating and near-surface mines. Rapid Airborne Mine Clearance System is a MK44 Bushmaster II cannon with a laser Light Detection and Ranging targeting fire control system that fires a flat-nosed, 30 mm, armor piercing, non-explosive, supercavitating projectile.

A hovering MH-60S helicopter uses the Light Detection and Ranging system to reacquire a mine previously located with a separate mine hunting system. Once a target is acquired, an onboard fire control subsystem automatically tracks it and aims the gun, firing the projectiles in bursts. A successful neutralization would disable the mine at a safe distance from the helicopter. Training targets are expendable, non-explosive, bottom and moored mine shapes.

13. Conduct Surface-to-Air Missile training**.** The Navy proposes to conduct up to 24 High Explosive Surface-to-Air Missile events annually in Virginia Capes Operating Area. In these air defense exercises, surface ships launch surface-to-air missiles with high explosive warheads at target drones simulating enemy aircraft. The Navy suspended live missile training launches from all surface ships except aircraft carriers in 2004; however, the Navy continues to conduct Surface-to-Air Missile test and evaluation events in the northern part of Virginia Capes Operating Area off-shore from the Goddard Flight Facility, Wallops Island, Virginia. If the Navy decides to reinstate Surface-to-Air Missile training events, it would conduct most of those events in the Virginia Capes Operating Area. Participants could include cruisers or destroyers launching SM-2 Standard Missiles, large amphibious ships (LHA or LHD) launching NATO Sea Sparrow missiles, or the smaller amphibious ships (LPD or LSD) launching Rolling Airframe Missiles. The targets are BQM-74 drones, launched from either G-1 Commercial Air Services aircraft or the Mobile Sea Range for SM-2 and Sea Sparrow missiles and BQM-34 drones launched from Dam Neck, Virginia.

These missiles have self-destruct mechanisms that cause the missiles to explode after a pre-set period of flight time. Therefore, the Navy does not anticipate any underwater detonations from high explosive warheads that fail to detonate near the target.

14. Establish or Enhance Training Opportunities in Specific Geographic Areas. The narratives that follow describe these training areas in greater detail and Table1 (at the end of this section) presents the total number of operations that the Navy would conduct on the proposed training areas.

MINE NEUTRALIZATION TRAINING AREA**.** Except for training with the new organic mine neutralization systems (Rapid Airborne Mine Clearance System and Airborne Mine Neutralization System), the Navy would continue mine warfare training missions involving MH- 53E and MH-60S helicopter as they currently occur. Most training operations would involve single-aircraft, unit-level training that is accomplished without training mines. These flights involve planning an appropriate search, deploying equipment, flying a search pattern, familiarizing operators with system procedures, and recovering equipment. Some systems would have an organic simulation capability.

To overcome some of the limitations of its current training operations, the U.S. Navy has established a Mine Neutralization Training Area in the Virginia Capes Operating Area underneath W-50C Special Use Airspace, which would be designated as a Safety Danger Zone pursuant to 33 CFR §334.390. The Navy proposes to deploy about 140 non-explosive, expendable mine shapes in the Virginia Capes Operating Area each year. The helicopters would concentrate their operations in two training minefields that would be about one square mile in size. The Navy also proposes to increase the number of underwater detonations training currently conducted by explosive ordnance disposal personnel from 24 events annually to 319 events annually. Navy personnel would use 5 lb net explosive weight charges in 9 events, 10 lb net explosive weight charges in 150 events and 20 lb net explosive weight charges in 160 events.

• *Airborne Mine Neutralization System Training Minefield* would support H-60 and H-53 operations with the explosive and non-explosive Airborne Mine Neutralization System. While most of these operations would use training neutralizers with no explosive materials, the Navy proposes to conduct about 30 operations per year with live warheads against expendable, non-explosive, bottom and moored mine shapes.

• *Rapid Airborne Mine Clearance System and Airborne Laser Mine Detection System Training Minefield* would support H-60 operations with the Rapid Airborne Mine Clearance System mine-neutralization system and Airborne Laser Mine Detection System mine-hunting system. Rapid Airborne Mine Clearance System is a 30-mm cannon that fires an armor-piercing, non-explosive, super-cavitating projectile that destroys the expendable, non-explosive, moored mine shapes. While Airborne Laser Mine Detection System is not a mine-neutralization activity, the Navy would take advantage of the moored training mines available in this training area.

MINE WARFARE TRAINING AREAS**.** The U.S. Navy has created six separate mine warfare training areas, two in the lower Chesapeake Bay and four in Virginia Capes Operating Area, primarily for enhanced mine countermeasures and neutralization Unit-Level Training.

Each training area would accommodate one to four individual minefields with semi-permanent training mines, and would be sized, located, and equipped to support several systems with similar criteria for water depth and distance from Naval Station Norfolk. The total capability would support training with all mine systems home based in the Hampton Roads area.

As the Navy consolidates its fleet of mine warfare-capable MH-53E and MH-60S helicopters at Naval Station Norfolk, the Virginia Capes Range Complex would become the backyard range for most mine warfare Unit-Level Training. Helicopter Unit-Level Training typically entails a high volume of single-aircraft sorties, typically lasting about four hours that begin and end at the home base, and should not involve extensive preparation of the training areas. Most mine operations currently conducted in the Virginia Capes Range Complex are done without training mines, which greatly reduces the effectiveness of training and reduce readiness.

The type of non-explosive mines in a particular mine warfare training area would depend on the characteristics of systems for which they are targets. The two broad categories of training mines include:

• *Non-explosive mine shapes*, which support mine hunting systems (sonar and/or laser sensors) and mine neutralization systems.

- *Versitile Exercise Mine Systems* (VEMS) support minesweeping systems (magnetic and/or acoustic signal generators). They are electronic devices shaped like bottom mines that detect and record acoustic and magnetic fields that pass over them. Each Versatile Exercise Mine System unit consists of a ballast section and a buoy section with all of the sensors. They do not contain any explosive material.

A surface vessel would seed a minefield with about 20 Versatile Exercise Mine System units that could remain in place for up to 90 days (but more typically for no more than 14 days) to support multiple events. A command from an acoustic link or at a programmed time activates the self-recovery system, causing the ballast section to release the buoy section. It rises to the surface, but remains tethered by a recovery line to the ballast section, which would act as an anchor. A surface vessel can then recover both sections. After extracting the data to provide feedback to the aircrew, maintenance personnel can reassemble and redeploy the Versatile Exercise Mine System unit.

The six mine warfare training areas overlay existing MH-53E preferred training areas. Each is located to satisfy depth, distance from their home base, and other requirements specific to the supported mine systems and helicopteror ship. Each training area would have one to four simulated threat minefields of about 4 nm^2, each with 10 to 25 non-explosive training mines.

- *Instrumented Training Area (South)* would support MH-53 operations with the MK-105 and SPU-1W mine sweeping systems. The overriding design criterion is distance from Naval Station Norfolk (within 15 nm). All other mine countermeasures systems are transported within the helicopter, allowing normal cruiseairspeeds (about 100 knots) to and from the training area. In contrast, the MK-105 is a bulky sled that must be streamed for operation at the departure point (in this case, the Naval Station Norfolk seawall) and dragged through the water to the training area. The SPU-1W is a 30-foot-long pipe, which is transported externally underneath the helicopter by a long cable during the transit to and from the training area. For both systems, the maximum transit speed is 27 knots. Because both systems operate on or just below the surface, their training areas can be in shallow water. This area would employ Versatile Exercise Mine System as training mines.

- *Instrumented Training Area (North)* would support H-53 operations with the MK-104 and MH-60S operations with the Organic Airborne and Surface Influence Sweep mine-sweeping systems. This area must have deeper water to ensure that the MK-104 and Organic Airborne and Surface Influence Sweep, both of which are underwater towed bodies, would not hit bottom. H-53s would occasionally use the area to train with the MK-106, which is a MK-104 attached to a MK-105 sled.

The Navy would regularly send small surface craft to both instrumened training areas to deploy and recoverVersatile Exercise Mine System units. Both of these factors, which reduce transit times from Naval Station Norfolk to the training area, encourage locating training sites in the lower Chesapeake Bay instead of the open ocean. This area would employ Versatile Exercise Mine System as training mines.

SONAR TRAINING AREAS would support H-53 operations with the AQS-24A; MH-60S operations with the AQS-20A;and cruiser, destroyer, and frigate operations with their hull-mounted mine hunting sonar systems. These areas must have deeper water to ensure that AQS-20 and AQS-24 systems, both of which are underwater towed bodies, would not hit bottom. The Navy has designated three separate sonar training areas in the Virginia Capes Range Complex:

• *Shallow Water Sonar Training Area (South).* This area, which is closest to Naval Station Norfolk, would host most (about 75%) of H-60 AQS-20 operations to accommodate its shorter on-station time compared tothe south training area, about 25 percent of the total AQS-20 operations, and about half of the H-53 AQS-24 operations. Also, most AQS-20 operations with the Remote Mine-hunting System (RMS) Unmanned Underwater Vehicle (UUV) would occur here. All training mines would be non-explosive bottom mine shapes.

• *Deep Water Sonar Training Area.* About half of H-53 AQS-24 operations and all surface ship operations would take place in this area. The training mines would be an even split of bottom and moored nonexplosive mine shapes.

Mine Neutralization Training Areas require three individual minefields with slightly different capabilities, all of which could be co-located in the same training area. The Navy proposes to deploy about 140 non-explosive expendable mine shapes each year in addition to the 319 underwater detonations conducted by explosive ordnance personnel.

• *MK-103 Training Minefield* would support H-53 operations with the MK-103, a mechanical mine sweeping system that consists of a Y-shaped, split cable dragged behind the helicopter that rides just below the surface. The cables have a series of cutters with small charges (0.002 lbs. Net Explosive Weight) that shear the anchoring cables of moored mines, releasing them to float to the surface. The cutters do not use live charges for most training flights. However, the Navy proposes to use live cartridges for about 25 percent of MK-103 training flights against non-explosive, moored mine shapes. In these live operations, after the cutter has sheered the mooring line connecting the non-explosive mine shape to its concrete anchor, themine shape would float to the surface where a boat can recover it. These operations would occur in W-50A and W-50C (Figure 1).

• *Airborne Mine Neutralization System Training Minefield* would support H-60 and H-53 operations with live and non-explosive Airborne Mine Neutralization System. While most of these operations would use training neutralizers with no explosive materials, the Navy proposes to conduct about 30 operations per year with live warheads against expendable non-explosive bottom and moored mine shapes. The Airborne Mine Neutralization System operations would occur in area W-50C.

• *Rapid Airborne Mine Clearance System and Airborne Laser Mine Detection System Training Minefield* would support H-60 operations with the Rapid Airborne Mine Clearance System mine-neutralization system (which is a 30-mm cannon that fires an armor-piercing, non-explosive, super-cavitating projectile that punctures the non-explosive, moored, mine shape). While the Airborne Laser Mine Detection System mine hunting system is not a mine-neutralization activity, the U.S. Navy would take advantage of the moored training mines available in this area to train with this system.

Rapid Airborne Mine Clearance System and Airborne Laser Mine Detection System operations would occur in area W-50C. The U.S. Navy requires a larger mine neutralization training area because training would include MK-103 with live cartridges, which are likely to be conducted in W-50A and C, where the Navy has already studied the environmental effects and received permits to conduct underwater detonations, and which the U.S. Army Corps of Engineers has already designated a Surface Danger Zone (33 CFR §334.390).

Table 1. Activities the U.S. Navy proposes to conduct in the Virginia Capes Range Complex

Range Operation	Platform	System or Ordnance	Proposed Action	Location
MINE WARFARE				
Mine Countermeasures	MH-53E	MK-103	200 sorties	W-50 A/C
		SPU-1W	70 sorties	Lower Chesapeake Bay
		MK-104	120 sorties	
		MK-105	120 sorties	
		AQS-24A	550 sorties	W-386, W-72
	MH-60S	OASIS	370 sorties	Lower Chesapeake Bay
		AQS-20A	670 sorties	W-386, W-72
		ALMDS	110 sorties	W-50C
	DDG 91+ (Remote Mine hunting System)	AQS-20A	12 events	W-386, W-72
Mine Neutralization	MH-53E	AMNS	70 sorties	W-50C
	MH-60S	AMNS	140 sorties (30 HE rounds)	W-50C
		RAMICS	110 sorties (2,750 rounds)	
	EOD	20 Lb NEW Charges	160 events	Surface Danger Zone (W-50C)
		10 LB NEW Charges	150 events	
		5 LB NEW Charges	9 events	
SURFACE WARFARE				
Bombing Exercise (air-to-surface)	F/A-18	MK-82 (500 lb HE bomb)	10 sorties (40 bombs)	W-386 (Air-K)
		MK-20 (non-explosive practice munitions or NEPM)	34 sorties (68 bombs)	W-72 A/B
		MK-76 (NEPM)	28 sorties (142 bombs)	
		MK-82 (NEPM)	75 sorties (150 bombs)	
		MK-83 (NEPM)	25 sorties (50 bombs)	
		BDU-45 (NEPM)	22 sorties (50 bombs)	

Table 1. Activities the U.S. Navy proposes to conduct in the Virginia Capes Range Complex

Range Operation	Platform	System or Ordnance	Proposed Action	Location
Bombing Exercise (air-to-surface)	F/A-18, F-35 (Joint Strike Fighter)	BDU-33, GBU-12, JDAM, JSOW, MK-76, MK-82, MK-84 (all NEPM)	77 sorties (77 bombs)	W-386 (Air-K)
Missile Exercise (Air-to-Surface)[7]	MH-60R/S, HH-60H	AGM-114 (Hellfire Missile HE)	60 sorties (60 missiles)	W-386 (Air-K; 75%), W-72A (25%)
	F/A-18, P-3C and P-8	AGM-65 E/F (Maverick; HE)	20 sorties (20 missiles)	W-386 (Air-K)
	F/A-18, F-35 (JSF) and H-60	AGM-14 (Hellfire) AGM-88 (HARM) AGM-65 LSR Maverick AGM-84 (Harpoon)	23 sorties	W-386 (Air-K)
Gunnery Exercise (Air-to-Surface)[8]	MH-53E	.50 cal machine gun	27 sorties (54,000 rounds)	W-72A (Air-1A; 75%) W-50C (25%)
	MH-60R/S	2.75-inch rockets	97 sorties (3,700 rounds)	W-386 (Air-K; 75%) W-72A (25%)
		.50 cal machine gun	330 sorties (264,000 rounds)	W-72A (Air-1A; 75%) W-50C (25%)
		M-240 (7.62 mm machine gun)	165 sorties (264,000 rounds)	W-72A (Air-1A; 75%) W-50C (25%)
	F/A-18, F-35 (JSF)	20 mm cannon (NEPM)	11 sorties (7,000 rounds)	W-386 (Air-K)
Gunnery Exercise (Surface-to-Surface; Boat)	Vessels such as small unit river craft, combat rubber raiding craft, rigid hull inflatable boats, and patrol craft	.50 cal, 7.62 mm	36 events (220,000 small caliber rounds)	W-50C (90%) R-6606 (10%)
		40 mm grenades	36 events (600 rounds)	
Gunnery Exercise (Surface-to-Surface; Ship)	CG, DDG	5 inch gun	115 events (2,430 rounds)	W-386 (80%) W-72 (20%)
	FFG	76 mm gun	22 events (370rounds)	
	CG, DDG, FFG, LHA, LHD, LPD, LSD	.50 cal machine gun	120 events (261,600 rounds)	
		25 mm machine gun	120 events (137,400 rounds)	
Laser Targeting	F/A-18	Maverick Laser Fire Control System	136 sorties	W-386 (Air-K) W-72A
	H-60	Hellfire Laser Fire Control System	136 sorties	
Maritime Security Operation (to include VBSS/MIO)	Rigid Hull Inflatable Boat or similar small boat,	none	92 events	Virginia Capes Operating Area

Table 1. Activities the U.S. Navy proposes to conduct in the Virginia Capes Range Complex

Range Operation	Platform	System or Ordnance	Proposed Action	Location
	and CG, DDG, FFG, LPD or LSD			
VBSS/MIO-Helicopter	H-60	none	44 events	Virginia Capes Operating Area
AIR WARFARE				
Air Combat Maneuvers	F/A-18	Captive carry missiles or telemetry pods	5,800 sorties	W-72A (Air-2A/B, 3A/B)
Gunnery Exercise (air-to-air)	F/A-18, F-35 (JSF)	20 mm cannon	60 sorties (15,000 rounds)	W-72A
Missile Exercise (Air-to-Air)	F/A-18	AIM-7, AIM-9, AIM-120	160 sorties (48 HE, 112 NEPM)	W-72A
	F/A-18	AIM-7, AIM-9, AIM-120, AIM-132 (ASRAAM)	33 sorties (33 missiles)	W-386 (Air D, G, H, K)
Missile Exercise (Surface-to-Air)	AOE, LHD, CVN	NATO Sea Sparrow	33 RDT&E events	W-386 (Air D, G, H, K)
	CG, LHA, AOE	Evolved NATO Sea Sparrow		
	CVN, FFG, LHA, LHD, LSD, LPD	Rolling Airframe Missile		
	CG, DDG	SM-2		
	CG, DDG, LHA, LHD, LSD, LPD	SM-2 (20 missiles); Sea Sparrow (2 missiles); RAM (2 missiles)	24 events	Virginia Capes Operating Area
Air Intercept Control	F/A-18, E-2C, CVN, CG, DDG, LHA, LHD	Air Search and fire control radars	370 events	W-386 and W-72
Detect-to-Engage	CG, DDG, FFG, LHA, LHD, LPD, LSD, CVN		225 events	
Gunnery Exercise (Surface-to-Air)	CG, DDG	5 inch gun	15 events (290 rounds)	W-386 (80%) W-72 (20%)
	FFG	76 mm gun (inert)	3 events (72 rounds)	
	CG, DDG, FFG, CVN, LHA, LHD, LPD, LSD	20 mm Close-in Weapons System	30 events (64,000 rounds)	
Strike Warfare				
HARM Missile exercise (air-to-surface)	F/A-18	AGM-88 (HARM)	26 sorties (26 missiles)	W-386 (Air E, F, I, J)
Amphibious Warfare				
Firing Exercise (Surface-to-Surface) with IMPASS	CG, DDG	5-inch gun (IMPASS)	22 events (1,540 rounds)	Preferred areas: W-386, 7C/D, 8C/D, W-72 (1C1/2) Secondary areas: W-386 (5C/D)

Table 1. Activities the U.S. Navy proposes to conduct in the Virginia Capes Range Complex

Range Operation	Platform	System or Ordnance	Proposed Action	Location
ELECTRONIC COMBAT				
Electronic Combat Operations	F/A-18, F-35 (JSF)	ALE-50/55 electronic jammer	10 sorties	W-386 (Air-K)
	F/A-18		110 sorties	W-386 (15%), W-72 (85%)
	AOE, CG, CVN, DDG, FFG, LHA, LHD, LPD, LSD	SLQ-32	182 events	Virginia Capes Operating Area
Chaff Exercise	CG, DDG, FFG, LCC, LHA, LHD, LPD, LSD	MK-214 or MK-216 Super Rapid Bloom Off-board Chaff	28 MK-214 events (168 canisters); 9 MK-216 events (54 canisters)	W-386 (85%) W-72 (15%)
	F/A-18, MH-60 R/S, F-35 (JSF)	R-144A/AL defensive chaff	14 sorties (140 canisters)	
	MH-60R/S	R-144A/AL defensive chaff	17 sorties (510 canisters)	W-386 (Air-K)
	F/A-18	R-144A/AL defensive chaff	1,950 sorties (19,500 canisters)	W-72 (85%), W-386 (15%)
Flare Exercise	MH-60R/S	Defensive flares	17 sorties (510 flares)	W-386 (Air-K)
	F/A-18, MH-60R/S, F-35 (JSF)		8 sorties (40 flares)	W-386 (85%), W-72 (15%)
	F/A-18		55 sorties (275 flares)	W-72 (85%), W-386 (15%)
TEST AND EVALUATIONS				
Shipboard Electronic Systems Evaluation Facility Utilization (SESEF)	All Hampton Roads-based ships	Radio and radar only	3,800 tests	Virginia Capes Operating Area (SESEF ULM-4 Range and RCS Range)

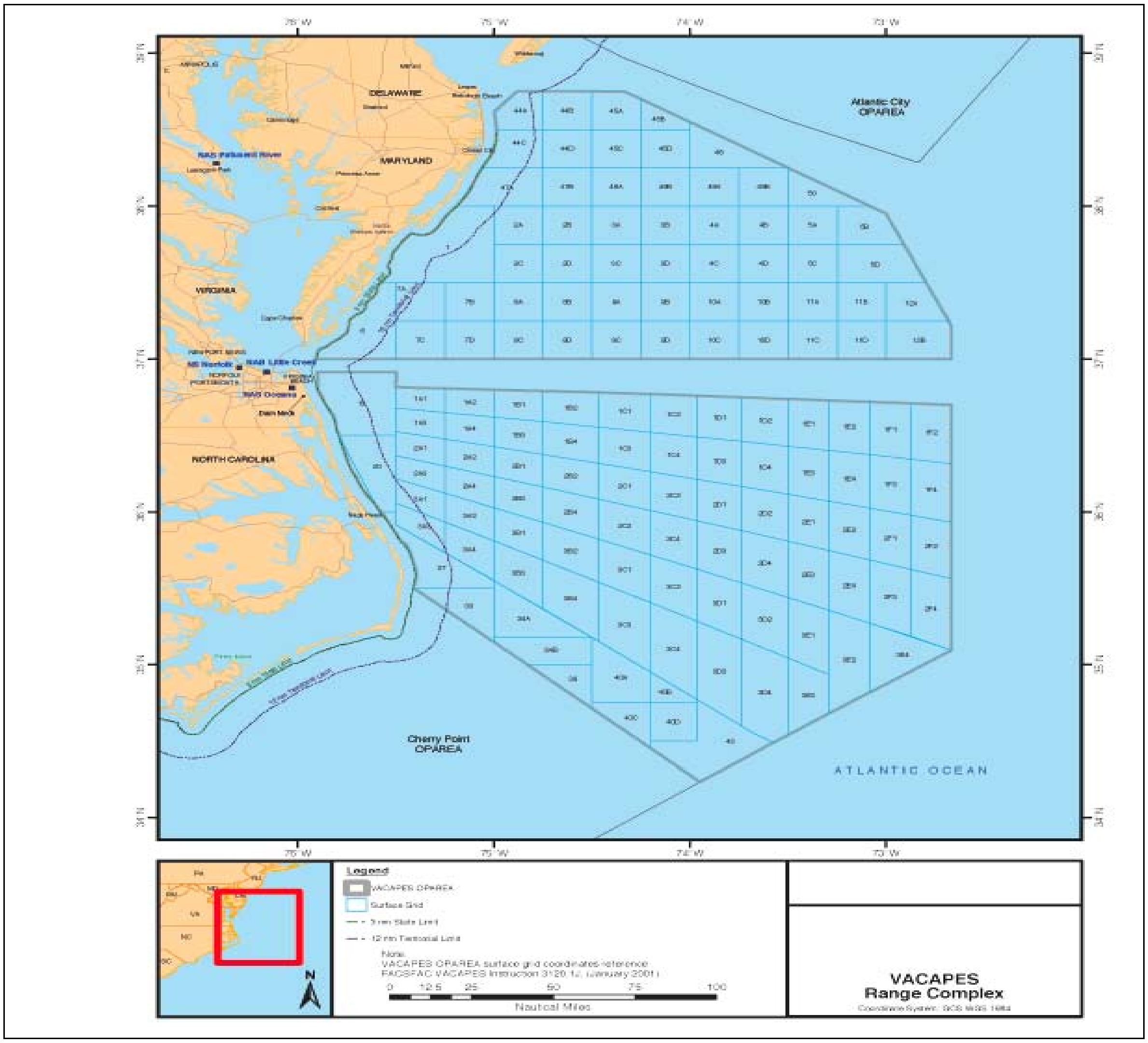

Figure 1. Map of the Virginia Capes Range Complex (from U.S. Navy 2008a)

1.3 Training in the Cherry Point Range Complex

In June 2009, the National Marine Fisheries Service issued a programmatic biological opinion that assessed the probable direct and indirect effects of the U.S. Navy's military readiness activities on the Cherry Point Range Complex on endangered and threatened species and designated critical habitat that is likely to occur on or near that range complex. That Opinion concluded that several of the activities the U.S. Navy plans to conduct on the range complex are not likely to adversely affect listed species or designated critical habitat because (1) the activities are not likely to produce stimuli that would represent potential stressors for endangered or threatened species or designated critical habitat under NMFS' jurisdiction; (2) the activities are likely to produce stimuli that would represent potential stressors for endangered or threatened species or designated critical habitat under NMFS' jurisdiction, but those species or critical habitat are not likely to be exposed to stressors; or (3) endangered or threatened species or designated critical habitat under NMFS' jurisdiction are likely to be exposed to potential stressors associated with the activities, but they are not likely to respond given that exposure. Specifically, endangered or threatened species or designated critical habitat under NMFS' jurisdiction are not likely to be exposed to stressors associated with the following activities:

1. AN/AES-1 Airborne Laser Mine Detection System is a non-towed (airborne) mine-hunting system designed to rapidly detect, classify, and locate near-surface floating or moored mines. A pod mounted on the MH-60S pylon contains the laser Light Detection and Ranging (LIDAR) system used to detect mines. An operator on the helicopter identifies potential mines from the laser images on a video monitor and marks their exact locations. A separate mine neutralization system is needed to disable or destroy mines once they have been identified. Our programmatic biological opinion concluded that these activities would introduce light associated with the LIDAR system into the marine environment, but endangered or threatened species under NMFS' jurisdiction are not likely to be aware of or respond to that light. There are no changes to these training operations that would change the conclusions of the 2009 programmatic biological opinion.

2. Commercial Air Services Support for Fleet Training. In 2009 the Navy proposed to increase the number, type, and operation of commercial air services within the Cherry Point Range Complex. Continuing to increase the use of commercial air services to support Fleet training would not substantially increase aircraft numbers, emissions, or time spent in the warning areas, or alter current airspace usage. Rather, commercial air services would displace Fleet assets now used to support Fleet training events. Our programmatic biological opinion concluded that these activities are not likely to directly or indirectly introduce potential stressors into the marine environment where endangered or threatened species under NMFS' jurisdiction might be exposed to those stressors. There are no changes to these training operations that would change the conclusions of the 2009 programmatic biological opinion.

3. Upgrade electronic combat capabilities at mid-Atlantic Electronic Warfare Range, which consists of a proposal to upgrade Mid-Atlantic Electronic Warfare Range threat emitters to include new mobile coastal anti-ship missile system simulators and add reactive Threat Radar Emitter System capability to several current threat emitters. Our programmatic biological opinion concluded that these activities are not likely to directly or indirectly introduce potential stressors into the marine environment where endangered or threatened species under NMFS' jurisdiction might be exposed to those stressors. There are no changes to these training operations that would change the conclusions of the 2009 programmatic biological opinion.

Because these activities are not likely to adversely affect endangered or threatened species under NMFS' jurisdiction, they will not be considered further in this document.

The following narratives summarize the remaining training operations the U.S. Navy plans to conduct on the Cherry Point Range Complex (see Figure 2 at the end of this section). Table 2 (at the end of this section) identifies the specific training activities and number of events for each activity while Chapter 2 and Appendix D of the U.S. Navy‘s Environmental Impact Statement and Overseas Environmental Impact Statement on the Cherry Point Range Complex provide more detailed narratives of these training operations and specific ordnance that might be involved in particular training operations (U.S. Navy 2008b).

1. MARITIME SECURITY SURGE SURFACE STRIKE GROUP TRAINING**.** The Navy proposes to use Navy Cherry Point Range Complex to prepare surface ships and embarked air, special forces and Marine Corps units for deployment as Maritime Security Surge Surface Strike Groups. Each fleet maintains a number of ships ready to deploy on short notice. Preparing a Maritime Security Surge Surface Strike Group for deployment includes a mix of classroom, synthetic and live training events. Live training ensures proficiency in multiunit procedures and autonomous operations by means of anticipated region-specific scenarios. The Navy does not expect Maritime Security Surge Surface Strike Group training to significantly alter the overall type and quantity of operations currently conducted in the Cherry Point Range Complex.

2. MINE WARFARE will only take place in the Navy Cherry Point Range Complex in conjunction with major exercises. Expeditionary Strike Group mine events will occur in Onslow Bay (Cherry Point Operating Area 15). Carrier Strike Group mine events will occur in Cherry Point Operating Areas 2, 4, 6, 11, 12, 13 and 14. See Bullet 15 below for a detailed description of these areas.

3. SURFACE WARFARE includes the following operations: Bombing exercises (air-to-surface) with nonexplosive practice munitions only throughout the Cherry Point Operating Area; Missile exercises (air-tosurface) in Cherry Point Operating Areas 16 and 17; Gunnery exercises (air-to-surface and surface-tosurface) throughout Cherry Point Operating Area; Maritime security operations, including maritime interception operations and visit, board, search and seizure operations, throughout the Cherry Point Operating Area.

4. AIR WARFARE includes the following operations: Air combat maneuvers in W-122 Areas 1, 8, 15 and 16; Gunnery exercises (air-to-air) in W-122 Areas 9, 10, 11 and 12; Missile exercises (air-to-air) in W-122Areas 1, 2, 3, 8, 9, 10, 15, 16 and 17; Missile exercises (surface-to-air) throughout W-122; Air intercept control exercises throughout W-122.

5. STRIKE WARFARE, which consists of High-Speed Anti-Radiation (HARM) missile exercises (air-to-surface), would occur within Cherry Point Operating Areas 18, 19, 20 and 21.

6. AMPHIBIOUS WARFARE which includes: Amphibious assaults that move Marine Corps amphibious forces by watercraft or aircraft from amphibious ships at sea over the beach to establish a beachhead then to occupy an area or to move inland for an extended period. These events occur in Cherry Point Operating Area 15 and the three mile littoral strip between the operating area and Onslow Beach on Marine Corps Base Camp Lejeune; Amphibious raids which involve Marine Corps amphibious forces from amphibious ships at sea to occupy land areas for a specified purpose and a specified time, followed by a planned withdrawal. These events occur in the same geographic area as amphibious assaults; Firing exercises with Integrated Maritime Portable Acoustic Scoring and Simulation System (IMPASS) which would occur in Cherry Point Operating Areas 4, 5, 13 and 14; Firing exercises into land targets in the G-10 Impact Area at Marine Corps Base Camp Lejeune. Navy ships will fire from Cherry Point Operating Area 15B.

7. ELECTRONIC COMBAT, which consist of chaff, flare and electronic combat operations occur throughout Cherry Point Operating Area.

8. RESEARCH, DEVELOPMENT, TEST AND EVALUATION, which could occur throughout Cherry Point Operating Area and are included in the estimates of the number of other events discussed in this *Description of the Proposed Action*.

9. SURFACE-TO-AIR MISSILE TRAINING**.** The Navy proposes to conduct up to eight surface-to-air missile training events annually in Cherry Point Operating Area. In these air defense exercises, surface ships launch surface-to-air missiles with either high explosive or non-explosive warheads at target drones simulating enemy aircraft.

However, the U.S. Navy would continue to conduct surface-to-air missile test and evaluation events in the northern part of the Virginia Capes Operating Area (W-386) offshore from the Goddard Flight Facility,Wallops Island, Virginia. If the Navy decides to reinstate surface-to-air missile training events, it would conduct most of them in the Virginia Capes Operating Area (W-72A/B), but would need the operational flexibility to train in Cherry Point Operating Area (W-122), as well. Participants could include cruisers or destroyers launching SM-2 Standard Missiles, or large amphibious ships (LHA or LHD) launching NATO Sea Sparrow missiles. Targets would be BQM-74 drones, launched from either G-1 Commercial Air Services aircraft or the Mobile Sea Range. Because the BQM-34 is the target of choice for the Rolling Airframe Missile, the Navy would schedule launches of these missiles in the Virginia Capes Operating Area.

10. MH-60R/S TRAINING**.** The Navy proposes to increase the type and quantity of MH-60R and MH-60S training conducted in the Cherry Point Range Complex. The on-going restructuring of its helicopter forces would eventually replace the aging fleet of CH-46D, UH-1N, HH-3U, SH-60B, SH-60F and HH-60H helicopters with these two linchpin airframes.

11. MH-60S MULTI-MISSION COMBAT SUPPORT. Helicopter missions would include organic mine countermeasures, combat search and rescue, special operations, logistics support, surface warfare, maritime intercept operations and search and rescue. Naval Station Norfolk would host all 100 airframes destined for the Atlantic Fleet, distributed between five carrier air wing squadrons, three expeditionary squadrons, and one fleet replacement squadron.

Most MH-60S operations in Cherry Point Range Complex would be with helicopters embarked aboard ships participating in major fleet training exercises. A carrier air wing squadron would deploy as an entire squadron onto the aircraft carrier when part of a Carrier Strike Group, whereas an expeditionary squadron would deploy one or two plane detachments aboard frigates, destroyers, cruisers and amphibious ships in support of an Expeditionary Strike Group.

Navy MH-60Ss would also launch from ships and fly inland to participate in Combat Search and Rescue and special operations battle problems during major exercises. The Marine Corps would address those operations in their separate Marine Corps Base Camp Lejeune and MCAS Cherry Point Range Complex Environmental Assessments.

12. MH-60R MULTI-MISSION TRAINING. Helicopter missions would include anti-submarine warfare, surface warfare, maritime interdiction operations, and search and rescue. The Atlantic Fleet would split the projected 105 airframes between Naval Air Station Jacksonville and Naval Station Mayport, distributed between five carrier air wing squadrons, two expeditionary squadrons, and one fleet replacement squadron.

Most MH-60R Unit-Level Training operations would occur in the Jacksonville Range Complex near their home bases. With few exceptions, the MH-60R would only train in the Cherry Point Range Complex when participating in a major exercise. The deployment and training patterns for the MH-60R resemble those for the MH-60S (discussed in previous item).

13. TRAINING WITH ORGANIC MINE COUNTERMEASURES SYSTEMS. The Navy proposes to accommodate operations of MH-60S helicopters, surface ships and submarines equipped with new Organic Mine Countermeasures systems in Navy Cherry Point Range Complex. Organic refers to the concept of embedding mine warfare capability into the strike group rather than as an external capability of

specialized ships and aircraft, only brought in on an as-needed basis. The Navy would configure 51 of the 102 MH-60Ss that would eventually be home-based at Naval Station Norfolk with Organic Mine Countermeasures capability. These systems include a towed mine hunting sonar (AQS-20A), a towed magnetic influence and acoustic mine sweeping body (OASIS), airborne mine hunting laser (ALMDS), submerged mine neutralization self-propelled device (Airborne Mine Neutralization System), and airborne mine neutralization ordnance (RAMICS).

14. ORGANIC AND SURFACE INFLUENCE SWEEP (designated AN/ALQ-220 and abbreviated as OASIS in Navy documents) is a high-speed (25 knots), towed, minesweeping system designed to rapidly neutralize magnetic and acoustic mines in shallow coastal waters. It emulates the magnetic and acoustic signatures of transit platforms, causing nearby mines to detonate. An underwater, towed body attached to a MH-60S helicopter with an electromechanical cable contains the electromagnetic field generator and the acoustic generator, a mechanical device that needs no external power.

15. AN/AES-1 AIRBORNE LASER MINE DETECTION SYSTEM is a non-towed (airborne) mine hunting system designed to rapidly detect, classify and locate near-surface floating or moored mines. A pod mounted on the MH-60S pylon contains the laser Light Detection and Ranging system used to detect mines. An operator on the helicopter identifies potential mines from the laser images on a video monitor and marks their exact locations. A separate mine neutralization system is needed to disable or destroy mines once identified.

16. AN/ASQ-235 AIRBORNE MINE NEUTRALIZATION SYSTEM is a non-towed system designed to identify and neutralize bottom and moored mines in the ocean environment. A hovering MH-60S or MH-53E helicopter lowers an expendable, self-propelled neutralizer device into the water at a safe distance from a potential mine previously identified with a separate mine hunting system. A fiber-optic cable connected to the neutralizer relays depth, position and sensor (sonar and video) information to the operator in the helicopter, who in turn sends control and guidance commands back to the neutralizer. The operator relocates and positively identifies the mine, and positions the neutralizer so its shaped charge would detonate into a vulnerable area. A successful neutralization renders the mine inoperable either by rupturing its case or, preferably, by triggering a sympathetic detonation of its charge. For training and testing purposes, the Airborne Mine Neutralization System explosive charge can be replaced with a ballast device that would cause the neutralizer to float to the surface for recovery and reuse after completion of the exercise. Training targets are expendable inert bottom and moored mineshapes.

17. RAPID AIRBORNE MINE CLEARANCE SYSTEM (designated A/AWS-2 and abbreviated as RAMICS in Navydocuments), is a non-towed system designed to neutralize floating and near-surface mines. Rapid Airborne Mine Clearance System is a MK44 Bushmaster II cannon with a laser Light Detection and Ranging targeting fire control system that fires a flat-nosed, 30 mm, armor piercing, non-explosive, super-cavitating projectile.

A hovering MH-60S helicopter uses the Light Detection and Ranging system to reacquire a mine previously located with a separate mine hunting system. Once the target is acquired, an onboard fire control subsystem automatically tracks it and aims the gun, firing the projectiles in bursts. A successful neutralization would disable the mine at a safe distance from the helicopter. Training targets are expendable, non-explosive, bottom and moored mine shapes.

Navy MH-53E and MH-60S helicopters would continue to train in Navy Cherry Point Range Complex in conjunction with major exercise mine warfare events, lasting seven to 14 days with up to four MH-53Es and three MH-60Ss. The mine training area for Expeditionary Strike Group exercises is in the shallower water where amphibious operations take place, whereas for Carrier Strike Group exercises, mine training occurs in the deeper water where the Carrier Strike Group would operate. The U.S. Navy currently conducts mine events in most major exercises without mine shapes, although exercise planners occasionally deploy temporary mine shapes in the Expeditionary Strike Group Operations Box off Onslow Beach in the Cherry Point Operating Area.

In the Cherry Point Range Complex, the Navy proposes to increase training above current baseline levels; as proposed, the number of most training operations would increase by about 10 percent above baseline. This increase in training operations results from changes in how the U.S. Navy is organizing, deploying, and employing naval forces (training Maritime Security Surge Surface Strike Groups) and changing the structure of Navy forces (for example, increasing the number of MH--60S Seahawk Multi-Mission Combat Support Helicopters at Naval Station Norfolk from four squadrons to nine and introducing Organic Mine Countermeasures systems).

18. ENHANCE MINE WARFARE TRAINING CAPABILITY. The U.S. Navy proposes to designate mine warfareTraining Areas in the Cherry Point Operating Area and the three-mile strip of Onslow Bay coastal waterseaward from Onslow Beach (see Figure 2) for enhanced mine warfare training during major exercises. The Navy proposes two separate mine warfare Training Areas in the Cherry Point Range Complex:

18.1 EXPEDITIONARY STRIKE GROUP MINE WARFARE TRAINING AREA. The Navy proposes to temporarilydeploy non-explosive recoverable training mines in the Expeditionary Strike Group mine warfareTraining Area for each mine warfare event, typically up to two weeks each for a maximum of threeExpeditionary Strike Group exercises in a surge year. It would recover these training mines at event completion.

A typical Expeditionary Strike Group major exercise mine warfare scenario would include mines in both the Expeditionary Strike Group Operating Box that threaten the Expeditionary Strike Group amphibious and support ships, and in the landing craft and amphibian transit lanes between the Expeditionary Strike Group Operating Box and the amphibious landing beach. These littoral waters are shallow enough that the Navy can easily deploy and recover training mines for the duration of the exercise mine warfare event.

Use of training mines greatly increases the quality of training for the mine warfare Commander and his aircrews who would gain experience coordinating their efforts to detect, identify, locate, and/or neutralize mines over a large area, and get feedback about the efficacy of their initial planning and subsequent revisions. The type of training mine in a particular area depends on characteristics of the systems for which they are targets. Two broad categories of non-explosive training mines include:

• *Inert mine shapes* support mine hunting systems (sonar and/or laser sensors) and mine neutralization systems. They replicate the appearance of mines that U.S. naval forces could encounter throughout the world. Inert mine shapes have an outer shell of glass- reinforced plastic or steel, contain no explosives or target detecting/actuating mechanisms, and are filled with concrete or some other inert material. They are available as bottom or moored mines. Moored mines float at a pre-programmed depth, and are held in place with steel cable or chain attached to an anchor. A surface support craft would deploy both bottom and moored mines (with mine shape, mooring line, and anchor as a pre-assembled unit) in the exercise area just prior to commencing the mine warfare event. Divers, working in conjunction with a surface support craft, would retrieve recoverable training mines at the conclusion of mine warfare events. Expendable mine shapes destroyed during mine neutralization operations are not recovered.

• *Versatile Exercise Mine System* support mine sweeping systems (magnetic and/or acoustic signal generators). They are electronic devices shaped like bottom mines that detect and record acoustic and magnetic fields that pass over them. Each Versatile Exercise Mine System unit consists of a buoy section with all the sensors and a ballast section, and contains no explosive material. As with the inert mine shapes, a surface support craft would seed the exercise area with Versatile Exercise Mine System units just before the mine warfare event. A command from either an acoustic link or at a preprogrammed time activates the self-recovery system, causing the ballast section to release the buoy section. It rises to the surface, but remains tethered by a recovery line to the ballast section which acts as an anchor. A surface vessel can then recover both sections. After extracting the data to provide feedback to the aircrew, maintenance personnel can reassemble and redeploy the Versatile Exercise Mine System unit.

A typical Expeditionary Strike Group major exercise mine warfare event would include up to four MH-53E and three MH-60S helicopters deployed to the exercise area one to two weeks before strike group arrival, operating from a ship participating in the exercise and/or shore-basing. Their mission is to clear the Expeditionary Strike Group Operating Area and landing craft transit lanes of mines. The MH-53s would fly two missions/day, three hours/mission, and the MH-60S would fly three missions/day, two hours/mission. Table 2 identifies the total number of operations for the mine countermeasures and mine neutralization systems the U.S. Navy plans to use over the course of three mine warfare events.

The Cherry Point Expeditionary Strike Group mine warfare Training Area would have three distinct sub-areas:

• *Expeditionary Strike Group Operating Box*, 3 to 12 nm seaward from Onslow Beach, between 15 and 25 nm wide. In this area, helicopters would use their mine sweeping (MK-103, MK-105 and OASIS) and sonar mine hunting (AQS-20A and AQS-24A) systems against about 20 bottom and 5 moored inert mine shapes, and 10 Versatile Exercise Mine System.

• *Landing Craft and Amphibian Transit Lanes*, from 3 nm to the shoreline of the Onslow Beach amphibious training area, about 3 nm wide. In this area, the helicopters would use their mine hunting systems (laser ALMDS, and sonar AQS-20A and AQS-24A in areas with at least 40' depth of water) against about 50 bottom and 20 moored inert mine shapes.

• *Mine Neutralization Area*, within the Underwater Detonation Area MH-60S helicopters would employ inert Airborne Mine Neutralization System and Rapid Airborne Mine Clearance System, and Explosive Ordnance Disposal divers would use up to 20 lb charges against up to 10 inert moored and bottom mine shapes. Exercise scenarios would geographically disperse mine neutralization events to prevent them from interfering with one another.

18.2 CARRIER STRIKE GROUP MINE WARFARE TRAINING AREA. Deep water 50 to 100 nm off the North Carolina coast frequently used an operating box during Carrier Strike Group major exercises. The U.S. Navy would conduct most Carrier Strike Group major exercise mine warfare events in the Jacksonville and Charleston Operating Areas, but would use the Navy Cherry Point Range Complex as an alternate location (generally not more than once during any year). Since water depths are too deep for routine retrieval of submerged objects, major training events that occurred in the Cherry Point Range Complex would take place without training mines. The Navy proposes to conduct mine neutralization operations for both Expeditionary Strike Group and Carrier Strike Group major exercises in the area currently designated for underwater detonation training (3 to 12 nm off the coast of Camp Lejeune in the Cherry Point Operating Area). Non-explosive expendable training mines used for these training operations are typically destroyed in place so they are not recovered. The Navy is developing a mine countermeasures and neutralization capability to embed in its Carrier Strike Groups and Expeditionary Strike Groups, and desires to improve the quality of the mine warfare training events in major exercises. Currently, most mine warfare events during major exercises in the Cherry Point Operating Area are typically paper exercises.

The Strike Group mine warfare Commander and his staff are presented with a mine problem for which they must plan a solution using all available mine countermeasures assets. However,typically the event does not involve any helicopters, ships, or submarines actually executing the plan. The obvious shortfall of this process is that neither the commander nor mine countermeasures units derive the benefit of working together to execute the plan, feedback on the plan's efficacy,and the opportunity to respond to real world contingencies that inevitably arise to complicate any plan. As Expeditionary Strike Groups and Carrier Strike Groups begin to embark with Organic Mine Countermeasures-configured MH-60S helicopters, exercise planners in the Navy's fleet would increase the amount of live mine warfare training events during major exercises.

A typical Carrier Strike Group major exercise mine warfare event would simulate two mine threat embayment with limited egress (also known as a "simulated choke point"). The Navy would deploy up to four MH-53E and three MH-60S helicopters to an exercise area one to two weeks before a strike group arrives; these aircraft would operate from a ship participating in the exercise, and would prepare safe transits for Carrier Strike Groups.

In deep water training areas, helicopters would execute the mine countermeasures plan with their mine hunting (AQS-20A and AQS-24A) and mine sweeping (Mk-103, Mk-105 and OASIS) systems. Aircrews would practice deploying their equipment in an operational environment, flying search patterns in proximity with other units, familiarizing the operators with system procedures, and recovering the equipment. In the shallow underwater detonation area, the Navy can insert up to mine neutralization equipment (inert Airborne Mine Neutralization System and Rapid Airborne Mine Clearance System), and deployed Explosive Ordnance Disposal personnel can practice their underwater detonation techniques.

Table 2. Activities the U.S. Navy proposes to conduct in the Cherry Point Range Complex (see U.S. Navy FEIS for further description and discussion)

Range Operation	Platform	System or Ordnance	Proposed Action	Location
MINE WARFARE				
Mine Countermeasures	MH-53E (Navy)	MK-103	54 sorties	Expeditionary Strike Group Composite Training Unit Exercise and Joint Task Force Exercise. Onslow Bay Mine Warfare Training Area. Carrier Strike Group Composite Training Unit Exercise: Carrier Operating Area North
		MK-105	54 sorties	
		AQS-24A	228 sorties	
	MH-60S (Navy)	OASIS	75 sorties	
		AQS-20A	165 sorties	
		ALMDS	84 sorties	
Mine Neutralization	MH-60S (Navy)	AMNS (non-explosive practice munitions or NEPM)	27 sorties	UNDET Area, Onslow Bay (3 – 12 nm from Onslow Beach)
		RAMICS	27 sorties (675 rounds)	
	Explosive Ordnance Disposal (Navy)	20 Lb NEW Charges	20 events	
SURFACE WARFARE				
Bombing Exercise (air-to-surface)	F/A-18 (Navy and USMC)	MK-82 or BDU-45 (NEPM)	25 events (98 bombs)	W-122
	AV-8B (USMC)	MK-82 or BDU-45 (NEPM)	12 events (96 bombs)	
	F/A-18 (Navy and USMC)	MK-83 (NEPM)	13 events (52 bombs)	
	F/A-18 (Navy)	MK-76 (25 lb NEPM)	14 events (142 bombs)	
	F/A-18 (USMC)	MK-76 (NEPM)	12 events (290 bombs)	
	AV-8B (USMC)	MK-76 (NEPM)	12 events (133 bombs)	
Missile Exercise (Air-to-Surface)[7]	AH-IW (USMC)	AGM-114 (Hellfire Missile)	8 sorties (6 HE missiles, 2 NEPM)	W-122 (Area 16, 17)
		TOW Missile (HE)	8 sorties (8 missiles)	
Gunnery Exercise (Air-to-Surface)[8]	AH-1W (USMC)	.20 mm cannon	40 sorties (12,000 rounds)	W-122 (Area 1, 2, 3, 8, 9, 10, 15, 16, 17)
	UH-1N (USMC)	.50 cal machine gun	40 sorties (60,000 rounds)	

Table 2. Activities the U.S. Navy proposes to conduct in the Cherry Point Range Complex (see U.S. Navy FEIS for further description and discussion)

Range Operation	Platform	System or Ordnance	Proposed Action	Location
		7.62 mm machine gun	40 sorties (60,000 rounds)	
	F/A-18 (USMC)	20 mm cannon	10 sorties (2,400 rounds)	W-122
	AV-8B (USMC)	25 mm cannon	10 sorties (2,400 rounds)	
Gunnery Exercise (Surface-to-Surface; Ship)	LHA, LHD, LSD, and LPD (Navy)	.50 cal machine gun	18 events (43,200 rounds)	Cherry Point Operating Area
		25 mm machine gun	18 events (28,800 rounds)	
	CG and DDG (Navy)	5-inch guns (NEPM)	27 events (1,140 rounds)	
	FFG (Navy)	76 mm (NEPM)	7 events 190 rounds)	
Gunnery Exercise (Surface-to-Surface; USMC small arms training)	LHA, LHD, LSD, and LPD (Navy)	9 mm pistol	30 events (12,000 rounds)	
		9 mm/.45 cal pistol, M-16, M-4, M-249 squad Automatic Weapon, MK-19, 40 mm TP, M-240-G machine gun, .50 cal machine gun (5.56,7.62 mm/,50 cal rounds)	30 events (12,000 rounds)	
		M-40 sniper rifle (.308 cal)	4 events (40 rounds)	
Maritime Security Operation (to include VBSS/MIO) Ship	Rigid Hull Inflatable Boat or similar small boat, and CG, DDG, FFG, LPD or LSD (Navy)	none	60 events	
Maritime Security Operation to include VBSS/MIO-Helo	MH-60 and CG, DDG, FFG, LPD or LSD (Navy)	none	8 events (24 sorties)	
AIR WARFARE				
Air Combat Maneuvers	F/A-18, AV-8B, F-15 and F-16 (Navy, USMC, and USAF)	Captive carry missiles or telemetry pods	770 sorties	W-122 (Areas 1, 8, 15, and 16)
Gunnery Exercise (air-to-air)	F/A-18 (USMC)	20 mm cannon	10 sorties (2,400 rounds)	W-122 (Areas 9, 10, 11, 12)
	AV-8B	25 mm cannon	10 sorties (2,400 rounds)	

Table 2. Activities the U.S. Navy proposes to conduct in the Cherry Point Range Complex (see U.S. Navy FEIS for further description and discussion)

Range Operation	Platform	System or Ordnance	Proposed Action	Location
Missile Exercise (Air-to-Air)	F/A-18 (USMC)	AIM-7 Sparrow (NEPM)	4 sorties (4 missiles)	
	F/A-18 (USMC)	AIM-7 Sparrow (NEPM)	4 sorties (4 missiles)	
Missile Exercise (Air-to-Air)	F/A-18 (USMC)	AIM-9 Sidewinder (HE)	4 sorties (4 missiles)	W-122 (Areas 9, 10, 11, 12)
	AV-8B (USMC)	AIM-9 Sidewinder (HE)	4 sorties (4 missiles)	
	AH-1W (USMC)	AIM-9 Sidewinder (HE)	4 sorties (4 missiles)	W-122 (Areas 1, 2, 3, 8, 9, 10, 15, 16, 17)
Missile Exercise (Surface-to-Air)	CG, DDG, LHA, LHD	SM-2 (HE); Sea Sparrow (HE)	8 events (8 missiles)	Cherry Point Operating Area
Air Intercept Control	F/A-18 (Navy and USMC)	Air Search and fire control radars	54 sorties 21 events	W-122
Strike Warfare				
HARM Missile exercise (Air-to-Surface)	F/A-18 (USMC)	AGM-88 (HARM HE)	8 sorties (8 missiles)	W-122 (Areas 18, 19, 20, 21)
Amphibious Warfare				
Firing Exercise (Land)	CG, DDG (Navy)	5-inch gun	30 events (3,000 rounds)	Cherry Point Operating Area (Firing Point Area 15B; the impact point is inland range at MCB Camp Lejeune Area G-10)
Firing Exercise with IMPASS		5-inch guns (70 rounds/event) [39 HE, 31 NEPM)	2 events (140 rounds, 78 HE, 62 NEPM)	Cherry Point Operating Area (Area 4/5, 13/14)
Amphibious Assault	1 LHA or LHD, 1 LPD, 1 1 LSD; 1 CG, up to 3 DDG and 2 FFG, with tailored MAGTF	11-14 amphibious AAV/EFV or LAV/LAR); 4 – 8 landing craft (3 – 5 LCACs, 1-3 LCU); 22 aircraft (4 MH-53, 12 H-46/MV-22, 4 AH-1M 2 UH-1, 4 AV-8)	4 assaults (52 AAVs and LAVs; 144 LCACs, 96 LCUs, 36 MH-53, 64 H-46 or MV-22, 36 AH-1, 24 UH-1, 16 AV-8)	Onslow Bay (90% of operations occur in Expeditionary Strike Group box, extending from Onslow Beach seaward 25 nm into Operating Area 15)
	1-3 amphibious ships (1 LHA or LHD, 1 LPD, 1 LSD), partial MAGTF	4-14 amphibious AAV/EFV or LAV/LAR); 2–8 landing LCAC/ LCU; 22 aircraft (4 MH-53, 12 H-46/MV-22, 4 AH-1, 2 UH-1, 4 AV-8)	6 assaults (42 AAVs and LAVs; 28 LCACs, 8 LCUs, 18 MH-53, 32 H-46 or MV-22, 18 AH-1, 12 UH-1, 8 AV-8)	
Amphibious Raid	1-3 amphibious ships (1 LHA or LHD, 1 LPD, 1 LSD), reinforced company (100 – 150 Marines)	4-14 amphibious AAV/EFV or LAV/LAR); 2–8 LCAC/ LCUs and small boats; 22 aircraft (4 MH-53, 12 H-46/MV-22, 4 AH-1, 2, UH-1, 4 AV-8)	24 raids (72 AAV/EFV or LAVLAR; 120 LCACs, 24 LCUs, 36 MH-53, 36 H-46 or MV-22, 36 AH-1, 36 UH-1, 36 AV-8)	

Table 2. Activities the U.S. Navy proposes to conduct in the Cherry Point Range Complex (see U.S. Navy FEIS for further description and discussion)

Range Operation	Platform	System or Ordnance	Proposed Action	Location
ELECTRONIC COMBAT				
Electronic Combat Operations	EA-6B, F/A-18G (Navy)	AN/ALQ-218, AN/ALQ-99, and AN/USQ-113	120 sorties	W-122
	All Navy and Marine Corps Fixed-wing aircraft	Multiple fixed and mobile SA, ZSU, and EW threat emitters	2,450 sorties	W-122
	AOE, CG, CVN, DDG, FFG, LHA, LHD, LPD, LSD	SLQ-32	50 events	Cherry Point Operating Area
Chaff Exercise	CG, DDG, FFG, LCC, LHA, LHD, LPD, LSD (Navy)	MK-214 (seduction chaff)	56 events (336 canisters)	
		MK-216 (distraction chaff)	18 events (108 canisters)	
	MH-60S	R-144A/AL defensive chaff	72 sorties (2,160 canisters)	W-122 (mostly areas 1, 8, 15, and 16)
	F/A-18, AV-8B (Navy and USMC)	R-144A/AL defensive chaff	500 sorties (5,000 canisters)	
Flare Exercise	MH-60S (Navy)	MK-46 MOD 1C, MJU-8A/B, MJU-27 A/B, MJU-32B, MJU-53B, SM-875/ALE	72 sorties (2,160 flares)	W-122 (Areas 1, 8, 15, and 16)
	F/A-18, AV-8B (Navy and USMC)		35 sorties (175 flares)	

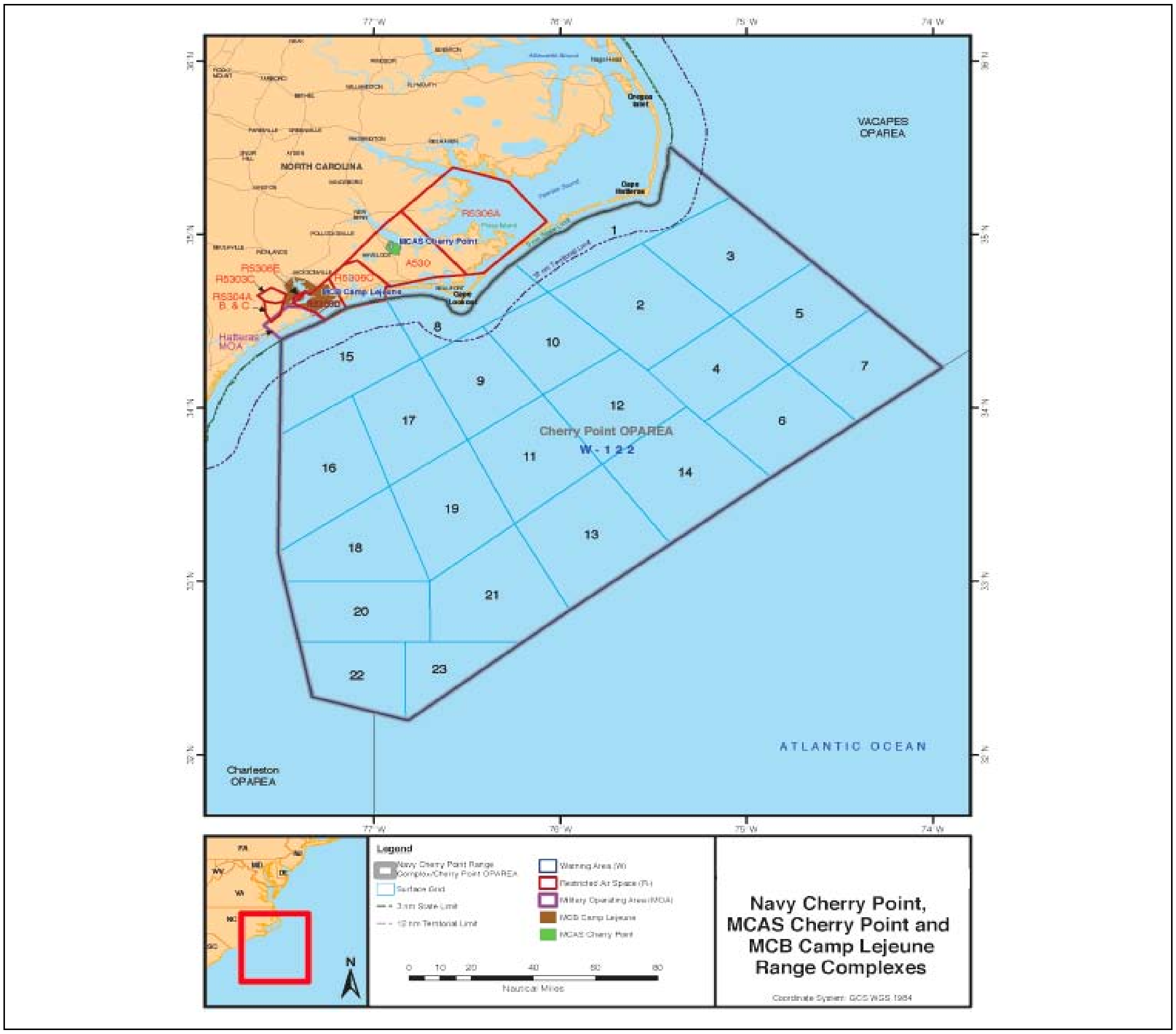

Figure 2. Map of the Cherry Point Range Complex (from U.S. Navy 2008b)

1.4 Training in the Jacksonville Range Complex

In June 2009, the National Marine Fisheries Service issued a programmatic biological opinion that assessed the probable direct and indirect effects of the U.S. Navy's military readiness activities on the Jacksonville Range Complex on endangered and threatened species and designated critical habitat that is likely to occur on or near that range complex. That Opinion concluded that several of the activities the U.S. Navy plans to conduct on the range complex are not likely to adversely affect listed species or designated critical habitat because (1) the activities are not likely to produce stimuli that would represent potential stressors for endangered or threatened species or designated critical habitat under NMFS' jurisdiction; (2) the activities are likely to produce stimuli that would represent potential stressors for endangered or threatened species or designated critical habitat under NMFS' jurisdiction, but those species or critical habitat are not likely to be exposed to stressors; or (3) endangered or threatened species or designated critical habitat under NMFS' jurisdiction are likely to be exposed to potential stressors associated with the activities, but they are not likely to respond given that exposure. Specifically, endangered or threatened species or designated critical habitat under NMFS' jurisdiction are not likely to be exposed to stressors associated with the following activities:

1. TEST AND EVALUATION, which consists of shipboard electronic systems evaluation facility utilization (SESEF). These training operations could occur throughout the Jacksonville Operating Area, although they are most likely to occur within SESEF ULM-4 Range and RCS Range. Our programmatic biological opinion concluded that these activities are not likely to directly or indirectly introduce potential stressors into the marine environment where endangered or threatened species under NMFS' jurisdiction might be exposed to those stressors. There are no changes to these training operations that would change the conclusions of the 2009 programmatic biological opinion.

2. AN/AES-1 Airborne Laser Mine Detection System is a non-towed (airborne) mine-hunting system designed to rapidly detect, classify, and locate near-surface floating or moored mines. A pod mounted on the MH-60S pylon contains the laser Light Detection and Ranging system used to detect mines. An operator on the helicopter identifies potential mines from the laser images on a video monitor and marks their exact locations. A separate mine neutralization system is needed to disable or destroy mines once they have been identified. Our programmatic biological opinion concluded that these activities would introduce light associated with the LIDAR system into the marine environment, but endangered or threatened species under NMFS' jurisdiction are not likely to be aware of or respond to that light. There are no changes to these training operations that would change the conclusions of the 2009 programmatic biological opinion.

3. AN/AQS-20**,** which is a towed, mine-hunting system designed to detect, classify, and localize bottom and moored mines in deep or shallow water. An underwater, towed body is attached to an MH-60S helicopter with an electromechanical cable that contains the high-frequency, high-resolution, side-looking, multi-beam sonar system. It can also be configured with an electro-optic identification sensor that incorporates a laser LIDAR system to identify bottom mines. An operator on the helicopter identifies potential mines from the sonar and laser images on a video monitor and marks their exact locations. A separate mine neutralization system is needed to disable or destroy mines once identified. Our programmatic biological opinion concluded that these activities would introduce light associated with the LIDAR system into the marine environment, but endangered or threatened species under NMFS' jurisdiction are not likely to be aware of or respond to that light. There are no changes to these training operations that would change the conclusions of the 2009 programmatic biological opinion.

4. Commercial Air Services Support for Fleet Training. In 2009 the Navy proposed to increase the number, type, and operation of commercial air services within the Jacksonville Range Complex. Continuing to increased use of commercial air services to support Fleet training would not substantially increase aircraft numbers, emissions, or time spent in the warning areas, or alter current airspace usage. Rather, commercial air services would displace Fleet assets now used to support Fleet training events. Our 2009 programmatic biological opinion concluded that these activities are not likely to directly or indirectly introduce potential stressors into the marine environment where endangered or threatened species under NMFS' jurisdiction might be exposed to those stressors. There are no changes to these training operations that would change the conclusions of the 2009 programmatic biological opinion.

In addition, our 2009 programmatic biological opinion on the Jacksonville Range Complex concluded that replacing P-3C Orion aircraft with P-8A Poseidon multi-mission aircraft was not likely to affect endangered or threatened species or designated critical habitat on the range complex. Because these activities are not likely to adversely affect endangered or threatened species under NMFS' jurisdiction, they will not be considered further in this document.

The following narratives summarize the remaining training operations the U.S. Navy plans to conduct on the Jacksonville Range Complex. Table 3 (at the end of this section) identifies the specific training activities and number of events for each activity while Chapter 2 and Appendix D of the U.S. Navy's Environmental Impact Statement and Overseas Environmental Impact Statement on the Jacksonville Range Complex provide more detailed narratives of these training operations and specific ordnance that might be involved in particular training operations (U.S. Navy 2008c).

1. MAJOR TRAINING EXERCISES consist of Carrier Strike Group Composite Training Unit Exercises, Expeditionary Strike Group Composite Training Unit Exercises, and Joint Task Force Exercises.

Carrier Strike Group Composite Unit Training Exercises involve an aircraft carrier, carrier air wing,surface and submarine units. Carrier Strike Group Composite Unit Training Exercises are nominally

21 days long. Typical events that occur during a Carrier Strike Group Composite Training Unit Exercise include flight operations; several coordinated mine, air defense, surface, electronic, and anti-submarine operations.

During Carrier Strike Group Composite Training Unit Exercises, anti-submarine warfare events could include a target submarine (or submarines) that follows pre-determined tracks within a specific geographic area while 3 to 6 surface vessels (cruisers, destroyers, and frigates) attempt to locate and track the submarines with passive sonar. Active mid-frequency sonar would be used if vessels in the Surface Group are proximate to a larger Navy vessel they are protecting or if the larger vessel is located beyong the effective range of passive sonar, sonobuoys, or dipping sonar. The majority of these exercises occur within the Jacksonville Range Complex although some events occur in the Cherry Point Range Complex and portions of the Virginia Capes Range Complex.

Expeditionary Strike Group Composite Training Unit Exercises involve Navy amphibious ships and U.S. Marine Corps units in maritime and amphibious operations. These training exercises typically include amphibious assaults; several amphibious raids; coordinated mine, air defense, surface, anti-submarine, electronic combat, strike operations, and urban-combat training. The amphibious events occur in the Cherry Point Range Complexes. Maritime events are split between the Jacksonville and Cherry Point Range Complexes.

During Expeditionary Strike Group COMPTUEX, anti-submarine warfare events could include a target submarine (or submarines) that follows pre-determined tracks within a specific geographic area while 3 to 6 surface vessels (cruisers, destroyers, and frigates) attempt to locate and track the submarines with passive sonar. About half of these exercises occur within the Jacksonville Range Complex with the other half occurring in the Cherry Point Range Complex.

Joint Task Force Training Exercises typically follow Carrier Strike Group Composite Training Unit Exercises and are unscripted, scenario-driven exercises. Joint Task Force Exercises usually last for about 10 days and involve one Strike Group consisting of the following participants:

> a. *Carrier Strike Group*: 1 multi-purpose carrier with a carrier air wing, 1 guided missile cruiser, 1 to 2 guided missile destroyer, 1 to 2 guided missile frigate, 1 fast combat support ship, and 1 submarine (SSN or SSGN).
>
> b. *Expeditionary Strike Group*: 1 amphibious assault ship (general purpose or multipurpose) with air wing, 1 guided missile cruiser, 1 to 2 guided missile destroyer, 1 to 2 guided missile frigate, 1 amphibious transport dock, 1 dock landing ship, 1 fast combat support ship, 1 submarine (SSN or SSGN), and embarked marines. Joint Task Force Exercises would primarily occur in the Jacksonville Range Complex with portions of events occurring in the Cherry Point Range Complex.

2. MINE WARFARE, which would consist of mine laying, mine countermeasures, and mine neutralization training operations. These exercises are designed to train Navy personnel to detect, identify, classify, mark, avoid, and disable sea mines using a variety of methods. The Navy proposes to decrease underwater detonation training from 12 events using 20 lb net explosive weight charges to an annual total of 10 events. All event would use 20 lb net explosive weight charges. These training operations would generally occur within the Lake George Range, throughout the Range Complex, and the North and South Underwater Detonation Areas (see Figure 3 and Table 3 at the end of this section).

3. SURFACE WARFARE, which would consist of bombing exercises (air-to-surface), air-to-surface missile exercises; air-to-surface and surface-to-surface gunnery exercises; laser targeting, maritime security operations, and maritime interdiction operations. The Navy proposes to increase air-to-surface missile exercises using the AGM-65 Maverick high explosive missile from 3 last year to 10 from 2011 to 2012. Air-to-surface missile exercises train aircrews to deliver missiles to surface targets, air-to-surface gunnery exercises train aircrews to attack surface targets with guns, surface-to-surface gunnery exercises train ship crews to attack surface targets with guns, and maritime security operations are designed to train Navy personnel to identify, track, intercept, board, and inspect surface vessels. Bombing operations would generally occur within areas W-158 (31-J), W-157A and W-157B, and W-158A and W-158B. Some air-to-surface missile exercises would occur in area W-157A while others would occur in area W-159A, air-to-surface and surface-to-surface gunnery exercises would occur in areas W-132, W-133, W-134, W-157 (AA, BB, or CC), W-158, or W-159A. Maritime Security Operations and Maritime Interdiction Operations would occur throughout the Charleston-Jacksonville Operating Area.

4. AIR WARFARE, which would consist of air combat maneuvers, air intercept control, chaff exercises, flare exercises, air-to-air missile exercises, surface-to-air missile exercises, surface-to-air gunnery exercises, air-to-air gunnery exercises, and detect to engage operations. Air combat maneuvers would generally occur within areas W-157A; air-to-air missile exercises would generally occur within areas W-132, W-133, W-134, W-157, and W-158; air-to-air gunnery exercises would generally occur within areas W-157A and W-133 (Area 2X); and Detect to Engage Operations would occur within areas W-132, W-133, W-134, W-157, and W-158. Flare Exercises would occur on the Lake George Range while chaff exercises, surface-to-air missile exercises, and surface-to-air gunnery exercises would occur throughout the Range Complex.

5. AMPHIBIOUS WARFARE would consist of firing exercises with Integrated Maritime Portable Acoustic Scoring and Simulation System (IMPASS) operations. In previous years the Navy would conduct 10 of these training operations in areas BB and CC. This year the Navy proposes to conduct five firing exercises with IMPASS in areas BB and CC and five exercises in the JAX deepwater IMPASS site. Exercises could occur year-round in these areas.

6. STRIKE WARFARE would consist of air-to-ground bombing exercises, combat, search, and rescue operations, and convoy operations. These training operations would occur on the Rodman Range.

7. Electronic Combat would consist of electronic combat operations, chaff operations and flare exercises. Electronic combat operations would generally occur on areas W-132, W-133, W-134, W-157, W-158, and elsewhere in the Jacksonville Range Complex; chaff operations would occur throughout the Range Complex; and flare exercises would occur on the Lake George Range Complex.

8. MARITIME SECURITY SURGE SURFACE STRIKE GROUP TRAINING**.** The Navy proposes to use the Jacksonville Range Complex for preparing surface ships and embarked air, special forces and Marine Corps units for deployment as Maritime Security Surge Surface Strike Groups. Each fleet maintains a number of ships ready to deploy on short notice. Preparing a Maritime Security Surge Surface Strike Group for deployment includes a mix of classroom, synthetic and live training events. Live training ensures proficiency in multiunit procedures and autonomous operations by means of anticipated region-specific scenarios. The Navy does not expect Maritime Security Surge Surface Strike Group training to significantly alter the overall type and quantity of operations currently conducted in the Jacksonville Range Complex.

9. SURFACE-TO-AIR MISSILE TRAINING**.** The Navy proposes to conduct up to eight surface-to-air missile training events annually in Jacksonville Range Complex. In these air defense exercises, surface ships launch surface-to-air missiles with either high explosive or non-explosive warheads at target drones simulating enemy aircraft.

However, the U.S. Navy proposes to continue surface-to-air missile test and evaluation events in the northern part of the Virginia Capes Operating Area (W-386) offshore from the Goddard Flight Facility on Wallops Island, Virginia. If the Navy decides to reinstate surface-to-air missile training events, it would conduct most of them in the Virginia Capes Operating Area (W-72A/B), but would need the operational flexibility to train in Charleston-Jacksonville Operating Areas (W-122), as well. Participants could include cruisers or destroyers launching SM-2 Standard Missiles, or large amphibious ships (LHA or LHD) launching NATO Sea Sparrow missiles. Targets would be BQM-74 drones, launched from either G-1 Commercial Air Services aircraft or the Mobile Sea Range. Because the BQM-34 is the target of choice for the Rolling Airframe Missile, the Navy would schedule launches of these missiles to the Virginia Capes Operating Area.

10. ORGANIC MINE COUNTERMEASURES SYSTEMS. The Navy proposes to accommodate operations of MH-60S the Jacksonville Range Complex. This would entail some changes in tactics, techniques, and procedures from current mine warfare training. “Organic” refers to the concept of embedding mine warfare capabilityinto the strike group rather than as an external capability of specialized ships and aircraft, only brought in on an as-needed basis. The Navy plans to configure 51 of the 102 MH-60Ss eventually home based at Naval Station Norfolk with Organic Mine Countermeasures capability. These systems include:

- Towed mine-hunting sonar (AN/AQS-20A);
- Towed magnetic influence and acoustic, mine-sweeping body (OASIS);

- Airborne mine-hunting laser (ALMDS);
- Submerged mine-neutralization, self-propelled devices using explosive charges (Airborne Mine Neutralization System); and
- Airborne, mine-neutralization ordnance (designated A/AWS-2 and abbreviated as RAMICS in Navy documents).

During a major exercise, multi-purpose helicopters (MH-60S) would take off from ships engaged in the exercise and practice “clearing” an area within the Charleston Operating Area or Jacksonville Operating Area before entry of the Strike Group. The MH-60S would fly at low altitude in the area to be cleared and would utilize mine hunting sonar (AQS-20). No mine shapes would be involved.

11. The Airborne Mine Neutralization System (designated AN/ASQ-235 and abbreviated as AMNS in Navydocuments) is a non-towed system designed to identify and neutralize bottom and moored mines in the ocean environment. A hovering MH-60S or MH- 53E helicopter lowers an expendable, self-propelled, neutralizer device into the water at a safe distance from a potential mine previously identified with a separate mine-hunting system. A fiber-optic cable connected to the neutralizer relays depth, position, and sensor (sonar and video) information to the operator in the helicopter, who sends control and guidance commands back to the neutralizer. The operator guides the lightweight (15.5 kg) and highly maneuverable vehicle to the target location using onboard high frequency sonar. After the target is viewed and positively identified with an on-board video camera, the operator fires an armor-piercing warhead from the vehicle to neutralize the mine.

For training and testing purposes, the airborne mine neutralization system explosive charge can be replaced with a ballast device that would cause the neutralizer to float to the surface for recovery and reuse after completion of the exercise. Training targets are expendable, non-explosive, bottom and moored mine shapes. The Navy evaluated the potential environmental effects of testing airborne mine neutralization system and concluded that significant impacts would not occur (U.S. Navy 2001; 2002b).

12. The Rapid Airborne Mine Clearance System (designated A/AWS-2 and abbreviated as RAMICS in Navy documents) is a non-towed system designed to neutralize floating and near-surface mines. Rapid Airborne Mine Clearance System is a MK44 Bushmaster II cannon with a laser Light Detection and Ranging targeting fire control system that fires a flat-nosed, 30 mm, armor piercing, non-explosive, super-cavitating projectile.

A hovering MH-60S helicopter uses the Light Detection and Ranging system to reacquire a mine previously located with a separate mine hunting system. Once the target is acquired, an onboard fire control subsystem automatically tracks it and aims the gun, firing the projectiles in bursts. A successful neutralization would disable the mine at a safe distance from the helicopter. Training targets are expendable, non-explosive, bottom and moored mine shapes.

13. The Organic and Surface Influence Sweep (designated AN/ALQ-220 and abbreviated as OASIS in Navy documents) is a high-speed (25 knots), towed, minesweeping system designed to rapidly neutralize magnetic and acoustic mines in shallow coastal waters. It emulates the magnetic and acoustic signatures of transit platforms, causing nearby mines to detonate. An underwater, towed body attached to a MH-60S helicopter with an electromechanical cable contains the electromagnetic field generator and the acoustic generator, a mechanical device that needs no external power.

Training operations in the Jacksonville Range Complex can consist of air combat maneuvers or ordnance delivery at land and water targets by a single aircraft, to Joint Task Force Exercises which may involve thousands of participants over a period of two weeks. Most of the training operations described above will remain at current levels for the next year. However, the Navy proposes to to increase the number of Air-to Surface MISSILEX training, decrease the number of underwater detonation training events and shift five FIREX with IMPASS training events to the Deepwater IMPASS site. In addition to these training operations, the U.S. Navy also proposes to conduct Maritime Security Surge Surface Strike Group (Independent Deployment) Training in the Jacksonville Complex, although the Navy does not expect this training to substantially change the general type and quantity of operations currently conducted in the Jacksonville Range Complex.

Table 3. Activities the U.S. Navy proposes to conduct in the Jacksonville Range Complex

Range Operation	Platform	System or Ordnance	Proposed Action	Location
MINE WARFARE				
Mine Countermeasures	MH-53E	MK-103	40 sorties	Amber Strait and Kaiser Carrier Operating Area[4]
		MK-105	40 sorties	
		AQS-14A & AQS-24A	160 sorties	
	MH-60S	OASIS	54 sorties	
		AQS-20A	162 sorties	
Mine Neutralization	MH-60S	AMNS (non-explosive practice munitions or NEPM)	27 sorties	Charleston Operating Area (10L and 12I)
		RAMICS	27 sorties	
	EOD	20 Lb NEW Charges	10 events	Charleston Operating Area (10L and 12I)
SURFACE WARFARE				
Missile Exercise (Air-to-Surface)	MH-60R/S, SH-60B, HH60-H	AGM-114 Hellfire (HE) (8-lb NEW)	70 sorties (70 missiles)	W-157A and W-159A (Missile Laser Training Area)
	P-3C and P-8A	AGM-65 Maverick (HE) (80-lb NEW)	10 sorties (10 missiles)	
Gunnery Exercise (Air-to-Surface)	H-60 (all models)	.50 cal machine gun	70 sorties (112,000 rounds)	W-132, W-133, W-134, W-157, W-158
	H-60 (all models), MH-68 (U.S. Coast Guard [USCG])	M-240 (7.62 mm) machine gun	84 sorties (192,000 rounds)	
	SH-60B, MH-60R, MH-68 (USCG)	.50 cal rifle	14 sorties (140 rounds)	W-157, W-158
Gunnery Exercise (Surface-to-Surface; Boat)	Harbor Defense Boats (Boston Whalers)	.50 cal guns	96 events (44,000 rounds)	Charleston Operating Area (UNDET North and South)
		M-60 and M-240 (7.62 mm)	96 events (49,300 rounds)	
		M-19 (40 mm rounds)	96 events (12,700 rounds)	
Gunnery Exercise (Surface-to-Surface; FAC/FIAC)	CG, DDG, FFG	none	9 events	Charleston-Jacksonville Operating Areas
Gunnery Exercise (Surface-to-Surface; Ship)	CG, DDG	5" gun	31 events (810 rounds)	Jacksonville Operating Area (Surface Gunnery Areas AA, BB, CC)
	FFG	76 mm gun	58 events (960rounds)	
	CG, DDG, FFG	.50 cal machine gun	44 events (105,800 rounds)	

Table 3. Activities the U.S. Navy proposes to conduct in the Jacksonville Range Complex

Range Operation	Platform	System or Ordnance	Proposed Action	Location
		25 mm machine gun	44 events (26,400 rounds)	
Bombing Exercise (Air-to-Surface)	P-3C, P-8A	MK-82(I), BDU-45 (500lb NEPM)	36 events (144 bombs)	W-157A/B W-158A/B
	F/A-18		90 events (360 bombs)	
Bombing Exercise (Air-to-Surface)	F/A-18	MK-83 (1,000 lb NEPM)	3 events (12 bombs)	W-157A/B W-158A/B
	F/A-18	MK-20 (cluster bomb, NEPM)	13 events (51 bombs)	W-157A/B W-158A/B
	F/A-18	MK-76 (25 lb NEPM with small smoke charge)	13 events (129 bombs)	W-157A/B W-158A/B
Laser Targeting	H-60	Hellfire Laser Fire Control System	275 sorties	W-132, W-133, W-134, W-157, W-158
	P-3C	Maverick Laser Fire Control System	28 sorties	W-132, W-133, W-134, W-157, W-158
Maritime Security Operation	Rigid Hull Inflatable Boat or similar small boat, and CG, DDG, FFG, LPD or LSD	none	90 events	Jacksonville and Charleston Operating Areas
VBSS/MIO-Helicopter	H-60	None	60 events	W-157A (Area 4X) and W-159A (Area 5X)
SMALL ARMS TRAINING				
Small Arms Training – Explosive hand grenades	Maritime Expeditionary Support Group (Various small boats)	MK3A2 Concussion anti-swimmer grenades (HE)	96 events (80 rounds)	Charleston Operating Area (10L and 12I)
AIR WARFARE				
Air Combat Maneuvers	F/A-18	Captive carry missiles or telemetry pods	1,245 sorties	W-157A (Area 3X, 4X)
Missile Exercise (Air-to-Air)	F/A-18	AIM-7, AIM-9, AIM-120 (30% HE, 70% NEPM)	22 sorties (7 HE, 15 NEPM)	W-132, W-133, W-134, W-157, W-158
Missile Exercise (Surface-to-Air)	CG, DDG LHA/LHD	SM-2 (6 missiles) Sea Sparrow (2 missiles)	8 events (8 missiles)	Jacksonville and Charleston Operating Areas
Air Intercept Control	F/A-18, E-2C, CVN, CG, DDG, LHA, LHD	Air Search and fire control radars	32 events (150 sorties)	W-132, W-133,W-134, W-157, W-158
Detect-to-Engage	CG, DDG, FFG, LHA,		85 events	W-132, W-133,W-134, W-157, W-158

Table 3. Activities the U.S. Navy proposes to conduct in the Jacksonville Range Complex

Range Operation	Platform	System or Ordnance	Proposed Action	Location
	LHD, LPD, LSD, CVN			
Gunnery Exercise (Surface-to-Air)	CG, DDG	5-inch gun (inert)	5 events (100 rounds)	Jacksonville Operating Area (Surface Gunnery Areas AA, BB, CC)
	FFG	76 mm gun (inert)	8 events (192 rounds)	
	CG, DDG, FFG	20 mm Close-in Weapons System	11 events (20,800 rounds)	
AMPHIBIOUS WARFARE				
Firing Exercise (Surface-to-Surface) with IMPASS	CG, DDG	5” gun (IMPASS)	10 events (390 HE rounds; 310 NEPM rounds)	Jacksonville Operating Area (Surface Gunnery Areas BB and CC and Deepwater IMPASS site)
ELECTRONIC COMBAT				
Electronic Combat Operations	EA-6B, F/A18G	AN/ALQ-218, AN/ALQ-99, AN/USQ-113	120 sorties	W-132, W-133, W-134, W-157, W-158
	CG, DDG, FFG,CVN, LHD, LPD, LSD	SLQ-32	61 events	Jacksonville and Charleston Operating Areas
Chaff Exercise	CG, DDG, FFG, LCC, LHA, LHD, LPD, LSD	MK-214 (seduction chaff)	56 events (336 canisters)	Jacksonville and Charleston Operating Areas
	CG, DDG, FFG, LCC, LHA, LHD, LPD, LSD	MK-216 (distraction chaff)	18 events (108 canisters)	Jacksonville and Charleston Operating Areas
	H-60B/R	RR-181/AL	9 sorties (9 canisters)	Jacksonville and Charleston Operating Areas
	F/A-18	R-144, R-129	415 sorties (4,150 canisters)	W-157A (Area 3X, 4X)
Flare Exercise	F/A-18	MK-46 MOD 1C, MJU-8A/B, MJU-27A/B, MJU-32B, MJU-53B, SM-875/ALE	14 sorties (70 flares)	W-157A (Area 3X, 4X)
TEST AND EVALUATIONS				
Shipboard Electronic Systems Evaluation Facility Utilization (SESEF)	CG, DDG, FFG	Radio and radar only	2,130 tests	5-15 nm east of Naval Station Mayport

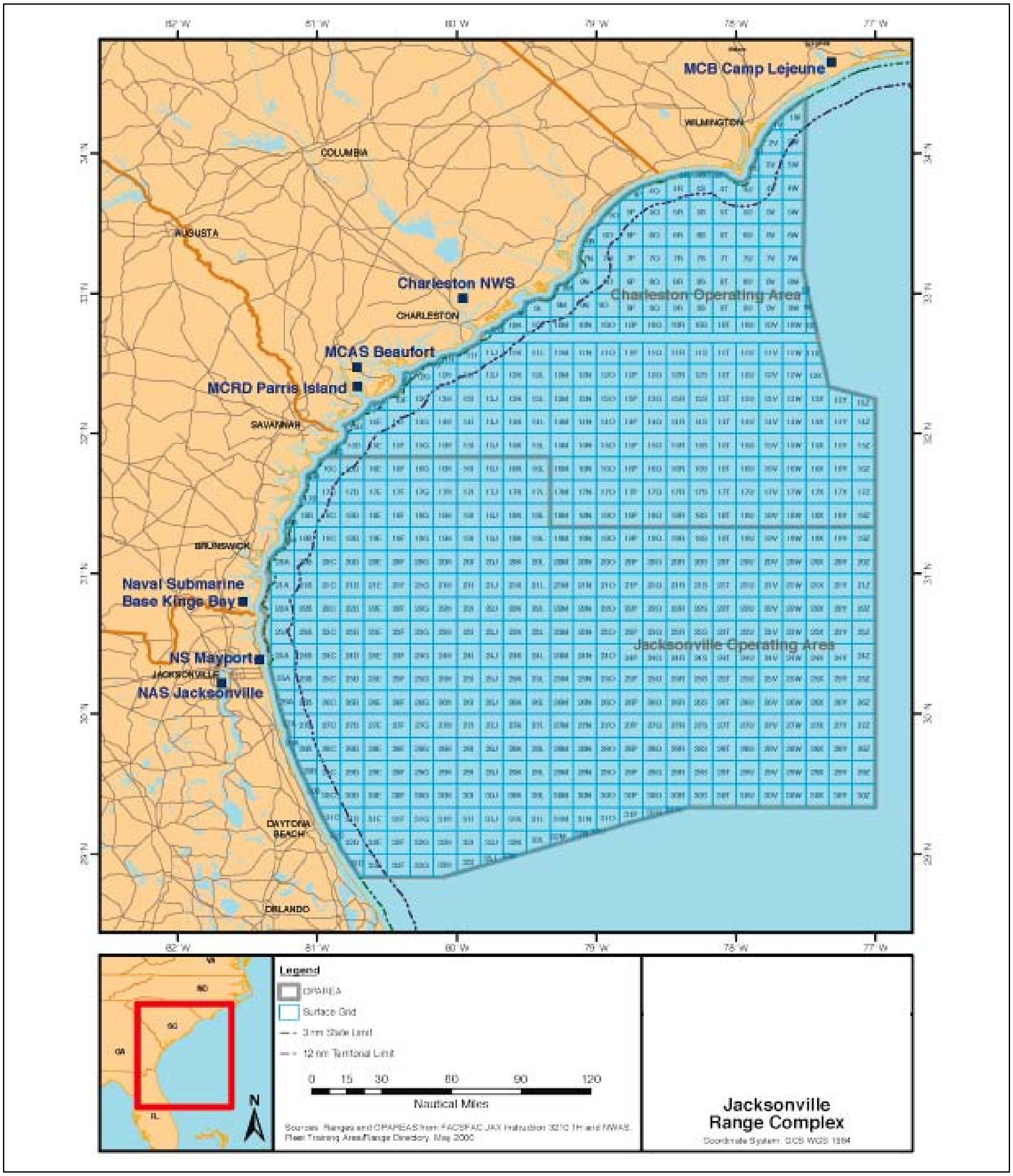

Figure 3. Map of the Jacksonville Range Complex (from U.S. Navy 2008c)

1.5 Scope of the Proposed MMPA Letters of Authorization

The Permits Division proposes to issue a Letter of Authorization for U.S. Navy training activities in the Virginia Capes Range Complex that would authorize non-lethal "take" of marine mammals by the Navy associated with training activities consisting of surface warfare [Missile Exercise (MISSILEX) and High-speed Anti-Radiation Missile Exercise (HARMEX)], mine warfare [Mine Exercises (MINEX)], amphibious warfare [Firing Exercise (FIREX)], strike warfare [Bombing Exercise (BOMBEX)], and vessel movement to, from, and within the VACAPES Range Complex Study Area. The proposed Letter of Authorization would authorize the "take" of marine mammals incidental to detonations of underwater explosives on the Virginia Capes Range Complex from June 2011 to June 2012.

The Permits Division proposes to issue a Letter of Authorization for U.S. Navy training activities in the Cherry Point Range Complex that would authorize non-lethal "take" of marine mammals by the Navy associated with training activities consisting of surface warfare [Missile Exercise (MISSILEX)], mine warfare [Mine Exercise (MINEX)], amphibious warfare [Firing Exercise (FIREX)], and vessel movement to, from and within the Cherry Point Range Complex Study Area. The proposed Letter of Authorization would authorize the "take" of marine mammals incidental to detonations of underwater explosives on the Cherry Point Range Complex from June 2011 to June 2012.

The Permits Division proposes to issue a Letter of Authorization for U.S. Navy training activities in the Jacksonville Range Complex that would authorize non-lethal "take" of marine mammals by the Navy associated with training activities consisting of surface warfare [Missile Exercise (MISSILEX)], mine warfare [Mine Exercises (MINEX)], amphibious warfare [Firing Exercise (FIREX)], small arms training (explosive hand grenades), and vessel movement to, from, and within the JAX Range Complex Study Area. The proposed Letter of Authorization would authorize the "take" of marine mammals incidental to detonations of underwater explosives on the Jacksonville Range Complex from June 2011 to June 2012.

1.6 Protective Measures the U.S. Navy Proposes to Employ

As required to satisfy the requirements of the Marine Mammal Protection Act of 1972, as amended, the U.S. Navy proposes to implement measures that would allow their training activities to have the least practicable adverse impact on marine mammal species or stocks (which includes considerations of personnel safety, practicality of implementation, and impact on the effectiveness of the "military readiness activity"). Those measures are summarized in this section of these Opinions; for a complete description of all of the measures applicable to the proposed exercises, readers should refer to the U.S.

Navy's request for a letter of authorization and the Permit Division's final rule governing authorization of the "take" of marine mammals pursuant to the Marine Mammal Protection Act of 1972, as amended.

The U.S. Navy does not currently conduct active sonar training in North Atlantic right whale critical habitat with the exception of object detection and navigation off shore Mayport, Florida and Kings Bay, Georgia; helicopter antisubmarine warfare training activities offshore Mayport, Florida; and torpedo exercises in the northeast during the months of August and September. As part of the proposed action, the U.S. Navy does not plan to conduct active sonar activities within the Stellwagen Bank, Monitor, Gray's Reef, Flower Garden Banks, and Florida Keys National Marine Sanctuaries and will avoid these sanctuaries by observing a 5 km (2.7 nautical mile or nm) buffer. In addition, the U.S. Navy proposes to use the following measures.

1.6.1 Personnel Training – Lookouts

The use of shipboard lookouts is a critical component of all Navy standard operating procedures. Navy shipboard lookouts (also referred to as "watchstanders") are highly qualified and experienced observers of the marine environment. Their duties require that they report all objects sighted in the water to the Officer of the Deck (e.g., trash, a periscope, marine mammals, sea turtles) and all disturbances (e.g., surface disturbance, discoloration) that may be indicative of a threat to the vessel and its crew. There are personnel serving as lookouts on station at all times (day and night) when a ship or surfaced submarine is moving through the water.

For the past few years, the Navy has implemented marine mammal spotter training for its bridge lookout personnel on ships and submarines. This training has been revamped and updated as the Marine Species Awareness Training and is provided to all applicable units. The lookout training program incorporates Marine Species Awareness Training, which addresses the lookout's role in environmental protection, laws governing the protection of marine species, Navy stewardship commitments, and general observation information, including more detailed information for spotting marine mammals. Marine Species Awareness Training has been reviewed by NMFS and acknowledged as suitable training.

1. All bridge personnel, Commanding Officers, Executive Officers, officers standing watch on the bridge, maritime patrol aircraft aircrews, and Mine Warfare helicopter crews will complete Marine Species Awareness Training.

2. Navy lookouts will undertake extensive training to qualify as a watchstander in accordance with the Lookout Training Handbook (NAVEDTRA 12968-D).

3. Lookout training will include on-the-job instruction under the supervision of a qualified, experienced watchstander. Following successful completion of this supervised training period, lookouts will complete the Personal Qualification Standard Program, certifying that they have demonstrated the necessary skills (such as detection and reporting of partially submerged objects).

4. Lookouts will be trained in the most effective means to ensure quick and effective communication within the command structure to facilitate implementation of protective measures if marine species are spotted.

5. Surface lookouts would scan the water from the ship to the horizon and be responsible for all contacts in their sector. In searching the assigned sector, the lookout would always start at the forward part of the sector and search aft (toward the back). To search and scan, the lookout would hold the binoculars steady so the horizon is in the top third of the field of vision and direct the eyes just below the horizon. The lookout would scan for approximately five seconds in as many small steps as possible across the field seen through the binoculars. They would search the entire sector in approximately five-degree steps, pausing between steps for approximately five seconds to scan the field of view. At the end of the sector search, the glasses would be lowered to allow the eyes to rest for a few seconds, and then the lookout would search back across the sector with the naked eye.

6. At night, to increase effectiveness, lookouts would not continuously sweep the horizon with their eyes. Instead, lookouts would scan the horizon in a series of movements that would allow their eyes to come to periodic rests as they scan the sector. When visually searching at night, they would look a little to one side and out of the corners of their eyes, paying attention to the things on the outer edges of their field of vision. Lookouts will also have night vision devices available for use.

1.6.2 Operating Procedures and Collision Avoidance

1. Prior to major exercises, the U.S. Navy proposes to issue a Letter of Instruction, Mitigation Measures Message or Environmental Annex to the Operational Order to further disseminate the personnel training requirement and general marine species mitigation measures.

2. Commanding Officers will make use of marine species detection cues and information to limit interaction with marine species to the maximum extent possible consistent with safety of the ship.

3. While underway, surface vessels will have at least two lookouts with binoculars; surfaced submarines will have at least one lookout with binoculars. Lookouts already posted for safety of navigation and manoverboard precautions may be used to fill this requirement. As part of their regular duties, lookouts will watch for and report to the Officer of the Deck the presence of marine mammals and sea turtles.

4. On surface vessels equipped with a mid-frequency active sonar, pedestal mounted “Big Eye” (20x110) binoculars will be properly installed and in good working order to assist in the detection of marine mammals and sea turtles in the vicinity of the vessel.

5. Personnel on lookout will employ visual search procedures employing a scanning method in accordance with the Lookout Training Handbook (NAVEDTRA 12968-D).

6. After sunset and prior to sunrise, lookouts will employ Night Lookouts Techniques in accordance with the Lookout Training Handbook (NAVEDTRA 12968-D).

7. While in transit, naval vessels will be alert at all times, use extreme caution, and proceed at a "safe speed" so that the vessel can take proper and effective action to avoid a collision with any marine animal and can be stopped within a distance appropriate to the prevailing circumstances and conditions.

8. When whales have been sighted in the area, Navy vessels will increase vigilance and take reasonable and practicable actions to avoid collisions and activities that might result in close interaction of naval assets and marine mammals. Actions may include changing speed and/or direction and are dictated by environmental and other conditions (*e.g.*, safety, weather).

9. Naval vessels will maneuver to keep at least 500-yd (460 m) away from any observed whale and avoid approaching whales head-on. This requirement does not apply if a vessel‘s safety is threatened, such as when change of course will create an imminent and serious threat to a person, vessel, or aircraft, and to the extent vessels are restricted in their ability to maneuver. Restricted maneuverability includes, but is not limited to, situations when vessels are engaged in dredging, submerged operations, launching and recovering aircraft or landing craft, minesweeping operations, replenishment while underway and towing operations that severely restrict a vessel‘s ability to deviate course. Vessels will take reasonable steps to alert other vessels in the vicinity of the whale.

10. Where feasible and consistent with mission and safety, vessels will avoid closing to within 200-yd (183 m) of sea turtles and marine mammals other than whales (whales addressed above).

11. Floating weeds, algal mats, *Sargassum* rafts, clusters of seabirds, and jellyfish are good indicators of sea turtles and marine mammals. Therefore, increased vigilance in watching for sea turtles and marine mammals will be taken where these are present.

12. Navy aircraft participating in exercises at sea will conduct and maintain, when operationally feasible and safe, surveillance for marine species of concern as long as it does not violate safety constraints or interfere with the accomplishment of primary operational duties. Marine mammal detections will be immediately reported to assigned Aircraft Control Unit for further dissemination to ships in the vicinity of the marine species as appropriate where it is reasonable to conclude that the course of the ship will likely result in a closing of the distance to the detected marine mammal.

13. All vessels will maintain logs and records documenting training operations should they be required for event reconstruction purposes. Logs and records will be kept for a period of 30 days following completion of a major training exercise.

1.6.3 Mitigation Measures Applicable to Vessel Transit During North Atlantic Right Whale Migration

In 1999, a Mandatory Ship Reporting System was implemented by the U.S. Coast Guard, which requires vessels larger than 300 gross registered tons (Department of the Navy ships are exempt) to report their location, course, speed, and destination upon entering the nursery and feeding areas of the right whale. At the same time, ships receive information on locations of right whale sightings, in order to avoid collisions with the animals. In the southeastern United States, the reporting system is from November 15 through April 15 of each year; the geographical boundaries include coastal waters within roughly 46 kilometers (km) (25 nautical miles [nm]) of shore along a 167 km (90 nm) stretch of the Atlantic coast in Florida and Georgia. In the northeastern United States, the reporting system is year-round and the geographical boundaries include the waters of Cape Cod Bay, Massachusetts Bay, and the Great South Channel east and southeast of Massachusetts; it includes all of Stellwagen Bank National Marine Sanctuary. A portion of the Boston Operating Area falls within these boundaries. Specific naval mitigation measures for each region of the East Coast Range Complexes are discussed in the following subsections.

Northeast Atlantic, Offshore of the Eastern United States

Prior to transiting the Great South Channel or Cape Cod Bay critical habitat areas, ships will obtain the latest right whale sightings and other information needed to make informed decisions regarding safe speed. The Great South Channel critical habitat is defined by the following coordinates: 41^{o}40N, 69^{o} 45W; 41^{o}00N, 69^{o}05W; 41^{o}38N, 68^{o}13W; 42^{o}10N, 68^{o}31W. The Cape Cod Bay critical habitat is defined by the following coordinates: 42^{o}04.8N, 70^{o}10W; 42^{o} 12N, 70^{o}15W; 42^{o}12N, 70^{o} 30W; 41^{o} 46.8N, 70^{o}30W.

Ships, surfaced subs and aircraft will report any North Atlantic right whale sightings (if the whale is identifiable as a right whale) off the northeastern U.S. to Patrol and Reconnaissance Wing (COMPATRECONWING). The report will include the time of sighting, lat/long, direction of movement (if apparent) and number and description of the whale(s). In addition, vessels or aircraft that observe whale carcasses will record the location and time of the sighting and report this information as soon as possible to the Regional Environmental Coordinator. All whale strikes must be reported. The report will include the date, time, and location of the strike; vessel course and speed; operations being conducted by the vessel; weather conditions, visibility, and sea state; description of the whale; narrative of incident; and indication of whether photos/videos were taken. Units are encouraged to take photos whenever possible.

Specific mitigation measures the U.S. Navy proposes to employ within the critical habitat or associated area of concern include the following:

1. Vessels will avoid head-on approach to North Atlantic right whale(s) and will maneuver to maintain at least 457 m (500 yd) of separation from any observed whale if deemed safe to do so. These requirements do not apply if a vessel's safety is threatened, such as when change of course would create an imminent

and serious threat to person, vessel, or aircraft, and to the extent vessels are restricted in the ability to maneuver.

2. When transiting within the critical habitat or associated area of concern, vessels shall use extreme caution and operate at a safe speed so as to be able to avoid collisions with North Atlantic right whales and other marine mammals, and stop within a distance appropriate to the circumstances and conditions.

3. Speed reductions (adjustments) are required when a whale is sighted by a vessel or when the vessel is within 9 km (5 nm) of a reported new sighting less than one week old.

4. Ships transiting in the Cape Cod Bay and Great South Channel critical habitats will obtain information on recent whale sightings in the vicinity of the critical habitat. Any vessel operating in the vicinity of a North Atlantic right whale shall consider additional speed reductions as per Rule 6 of International Navigational Rules.

Mid-Atlantic, Offshore of the Eastern United States

For the purposes of its proposed mitigation measures, the U.S. Navy defines the mid-Atlantic broadly to include ports south and east of Block Island Sound southward to South Carolina. The U.S. Navy proposes to establish the procedures described below as mitigation measures for Navy vessel transits during North Atlantic right whale migratory seasons near ports located off the western North Atlantic, offshore of the eastern United States. The measures would apply to all Navy vessel transits, including those vessels that would transit to and from East Coast ports and operating areas. Seasonal migration of North Atlantic right whales is generally described by NMFS as occuring from October 15th through April 30th, when right whales migrate between feeding grounds farther north and calving grounds farther south. The measures have been established in accordance with dates identified by NMFS consistent with these seasonal patterns.

NMFS has identifed ports located in the western Atlantic Ocean, offshore of the southeastern United States, where vessel transit during North Atlantic right whale migration is of highest concern for potential ship strike. The ports include the Hampton Roads entrance to the Chesapeake Bay, which includes the concentration of Atlantic Fleet vessels in Norfolk, Virginia. Navy vessels are required to use extreme caution and operate at a slow, safe speed consistent with mission and safety during the months indicated in Table 4 and within a 20 nm (37 km) arc (except as noted) of the specified reference points.

During the months identified in Table 4, Navy vessels would practice increased vigilance with respect to avoidance of vessel-whale interactions along the mid-Atlantic coast, including transits to and from any mid-Atlantic ports not specifically identified above. All surface (d) units transiting within 56 km (30 nm) of the coast in the mid-Atlantic would ensure at least two watchstanders are posted, including at least one lookout that has completed required Marine Species Awareness Training training. Furthermore, Navy vessels would not knowingly approach any whale head on and would maneuver to keep at least 500 yards (457 m) away from any observed whale, consistent with vessel safety.

1.6.4 Southeast Atlantic, Offshore of the Eastern United States

1. The following measures would be applicable to the "Consultation Area" in the Jacksonville Range Complex during North Atlantic Right Whale Calving season. Fleet Area Control and Surveillance Facility-Jacksonville provides an information resource through the right whale sightings clearinghouse.

During calving season and within the consultation area (roughly an area to 80 nm seaward from Charleston, South Carolina, south to Sebastian Inlet, Florida) particular measures are in effect in accordance with NMFS' 1997 Biological Opinion U.S. Navy activities off the southeastern United States along the Atlantic coast (NMFS 1997). The U.S. Navy proposes to continue implementing the following measures from that biological opinion during the North Atlantic right whale calving season (November 15 – April 15):

Table 4. North Atlantic Right Whale Migration Port References

Region	Months	Port Reference Points
South and East of Block Island	September–October and March–April	20 nm seaward of line between 41°4.49N to 71°51.15W and 41°18.58N to 70°50.23W
New York / New Jersey	Sep–Oct and Feb-Apr	40°30.64N to 73°57.76W
Delaware Bay (Philadelphia)	Oct–December and February–March	38°52.13N to 75°1.93W
Chesapeake Bay (Hampton Roads and Baltimore)	November-December and February–April	37°1.11N to 75°57.56W
North Carolina	December–April	34°41.54N to 76°40.20W
South Carolina	October–April	33°11.84N to 79°8.99W 32°43.39N to 79°48.72W

1.1. Naval vessels operating within North Atlantic right whale critical habitat[1] and the Associated Area of Concern[2] will exercise extreme caution and use slow safe speed, that is, the slowest speed that is consistent with essential mission, training, and operations.

1.2. Exercise extreme caution and use slow, safe speed when a whale is sighted by a vessel or when the vessel is within 5 nm of a reported new sighting less than 12 hours old.

[1] This critical habitat is the area from 31-15N to 30-15N extending from the coast out to 28 km (15 nm), and the area from 28-00N to 30-15N from the coast out to 9 km (5 nm).

[2] The AAOC is the area extending 5 nm seaward of the designated critical habitat boundaries.

1.3. Circumstances could arise where, in order to avoid North Atlantic right whale(s), speed reductions could mean vessels must reduce speed to a minimum at which it can safely keep on course (bare steerageway) or vessels could come to an all stop.

1.4. During the North Atlantic right whale calving season north-south transits through the critical habitat are prohibited, except for those exercises that necessarily operate at a slow, safe speed. Naval vessel transits through the area shall be in an east-west direction, and shall use the most direct route available during the calving season.

1.5. Naval vessel operations in the North Atlantic right whale critical habitat and Associated Area of Concern during the calving season will be undertaken during daylight and periods of good visibility, to the extent practicable and consistent with mission, training, and operation. When operating in the critical habitat and Associated Area of Concern at night or during periods of poor visibility, vessels will operate as if in the vicinity of a recently reported North Atlantic right whale sighting.

1.6. Fleet Area Control and Surveillance Facility-Jacksonville shall coordinate ship/aircraft clearance into the operating area based on prevailing conditions, including water temperature, weather conditions, whale sighting data, mission or event to be conducted and other pertinent information. Commander Submarine Atlantic (COMSUBLANT) will coordinate any submarine operations that may require clearance with Fleet Area Control and Surveillance Facility-Jacksonville. Fleet Area Control and Surveillance Facility-Jacksonville will provide data to ships and aircraft, including U.S. Coast Guard if requested, and will recommend modifying, moving or canceling events as needed to prevent whale encounters. Commander Submarine Group Ten (COMSUBGRU TEN) will provide same information/guidance to subs.

1.7. Prior to transiting or training in the critical habitat ships will contact Fleet Area Control and Surveillance Facility-Jacksonville to obtain latest whale sighting and other information needed to make informed decisions regarding safe speed and path of intended movement. Submarines shall contact Commander Submarine Group Ten for similar information. Ships and aircraft desiring to train/operate inside the critical habitat or within the warning/operating area shall coordinate clearance with Fleet Area Control and Surveillance Facility-Jacksonville. Submarines shall obtain same clearance from CTF-82 (Commander Submarine Atlantic).

1.8. Fleet Area Control and Surveillance Facility-Jacksonville will coordinate local procedures for whale data entry, update, retrieval and dissemination using joint maritime command information system. Ships not yet Officer in Tactical Command Information Exchange subsystem capable, including U.S. Coast Guard, will communicate via satellite communication, high frequency, telephone or international marine/maritime satellite.

1.9 .The only types of exercises that may be conducted inside the critical habitat and Associated Area of Concern in calving season are precision anchorage drills, swept channel exercises and maritime security operations. In addition, use of the Shipboard Electronic System Evaluation Facility range is authorized with clearance and advice from Fleet Area Control and Surveillance Facility-Jacksonville.

2. North Atlantic Right Whale Early Warning System

2.1. The coastal waters off the Southeast United States support the only known calving ground for the North Atlantic Right Whale. In the mid 1990's, the United States (U.S.) Navy, U.S. Coast Guard, U.S. Army Corps of Engineers, and National Marine Fisheries Service entered into a Memorandum of Agreement pursuant to the Endangered Species Act of 1973, as amended. The Early Warning System is a result of that agreement and is a collaborative effort which involves comprehensive aerial surveys conducted during the North Atlantic Right Whale calving season. Surveys are flown daily, weather permitting, from December 1st through March 31st. East/west transects are flown from shoreline to approximately 30-35 nm offshore. Aerial surveys are conducted to locate North Atlantic right whales and provide whale detection and reporting information to mariners in the North Atlantic right whale calving ground in an effort to avoid collisions with this endangered species. When a North Atlantic right whale is sighted, information from the aerial survey aircraft is passed to a ground contact. The ground contact e-mails the sighting information to a wide network distribution which includes Fleet Area Control and Surveillance Facility-Jacksonville, the U.S. Coast Guard, U.S. Army Corps of Engineers, and non-profit and commercial interests. Additionally, the ground contact will follow up with a call to Fleet Area Control and Surveillance Facility-Jacksonville to provide further information if necessary. Fleet Area Control and Surveillance Facility-Jacksonville records this valuable information and disseminates to all Navy vessels and aircraft operating in the consultation area via the Secret Internet Protocol Router Network system. General sighting information and reporting procedures are broadcasted over the following methods: the NOAA weather radio; U.S. Coast Guard’s NAVTEX system and a Broadcast Notice to Mariners over VHF marine-band radio channel 16. The Early Warning System is a wide communication effort to ensure all vessels in the area are aware of the most recent right whale sightings as an avoidance measure.

3. Surface-to-Surface Gunnery (up to and including 5-inch explosive rounds)

3.1. Lookouts will visually survey for floating weeds, algal mats, and *Sargassum* rafts, which may be inhabited by immature sea turtles, in the target area. Intended target area shall not be within 600 yards (548 m) of known or observed floating weeds, algal mats, *Sargassum* rafts, or coral reefs.

3.2. If applicable, target-towing vessels shall maintain a trained lookout for marine mammals and sea turtles. If a marine mammal or sea turtle is sighted in the vicinity, the tow vessel will immediately notify the firing vessel, which will suspend the exercise until the area is clear.

3.3. A 600 yard (548 m) radius buffer zone will be established around the intended target.

3.4. From the intended firing position, trained lookouts will survey the buffer zone for marine mammals and sea turtles prior to commencement and during the exercise as long as practicable. Due to the distance between the firing position and the buffer zone, lookouts are only expected to visually detect breaching whales, whale blows, and large pods of dolphins and porpoises.

3.5. The exercise will be conducted only when the buffer zone is visible and marine mammals and sea turtles are not detected within the target area and the buffer zone.

4. Surface-to-Surface Gunnery (up to and including 5-inch non-explosive rounds)

4.1 Lookouts will visually survey for floating weeds, algal mats, and *Sargassum* rafts which may be inhabited by immature sea turtles in the target area. Intended target area shall not be within 200 yards (182 m) of known or observed floating weeds, algal mats, *Sargassum* rafts, or coral reefs.

4.2. A 200 yard (182 m) radius buffer zone will be established around the intended target.

4.3. From the intended firing position, trained lookouts will survey the buffer zone for marine mammals and sea turtles prior to commencement and during the exercise as long as practicable. Due to the distance between the firing position and the buffer zone, lookouts are only expected to visually detect breaching whales, whale blows, and large pods of dolphins and porpoises.

4.4. If applicable, target-towing vessels shall maintain a trained lookout for marine mammals and sea turtles. If a marine mammal or sea turtle is sighted in the vicinity, the tow vessel will immediately notify the firing vessel, which will suspend the exercise until the area is clear.

4.5. The exercise will be conducted only when the buffer zone is visible and marine mammals and sea turtles are not detected within the target area and the buffer zone.

5. Firing Exercise using the Integrated Maritime Portable Acoustic Scoring System or IMPASS (5-in. explosive rounds). Note: This exercise is also known as Firing Exercise II and Naval Surface Fire Support.

5.1. Firing Exercise using IMPASS will only be conducted in Areas 1C1/2, 7C/D, 8C/D and 5C/D of the Virginia Capes Range Complex, in Areas 4, 5, 13, or 14 of the Cherry Point Range Complex, and in Areas BB, CC and the Deepwater IMPASS site of the Jacksonville Range Complex.

5.2. Pre-exercise monitoring of the target area will be conducted with "Big Eyes" prior to the event, during deployment of the IMPASS sonobuoy array, and during return to the firing position. Ships will maintain a lookout dedicated to visually searching for marine mammals and sea turtles 180° along the ship track line and 360° at each buoy drop-off location.

5.3. "Big Eyes" on the ship will be used to monitor a 600 yd (548 m) buffer zone around the target area for marine mammals/sea turtles during naval-gunfire events. Due to the distance between the firing position and the buffer zone, lookouts are only expected to visually detect breaching whales, whale blows, and large pods of dolphins and porpoises.

5.4. Ships will not fire on the target if any marine mammals or sea turtles are detected within or approaching the 600 yd (548 m) buffer zone until the area is cleared. If marine mammals or sea turtles are present, operations would be suspended. Visual observation will occur for approximately 45 minutes, or until the animal has been observed to have cleared the area and is heading away from the buffer zone.

5.5. Post-exercise monitoring of the entire effect range will take place with "Big Eyes" and the naked eye during the retrieval of the IMPASS sonobuoy array following each firing exercise.

5.6. Firing Exercise with IMPASS will take place during daylight hours only.

5.7. Firing Exercise with IMPASS will only be used in Beaufort Sea State three (3)[3] or less.

5.8. The visibility must be such that the fall of shot is visible from the firing ship during the exercise.

5.9. No firing will occur if marine mammals are detected within 70 yd (64 m) of the vessel.

5.10. During North Atlantic right whale calving season, no explosive ordnance shall be used in Areas BB and CC.

[3] The Beaufort Scale of Wind Force was developed as a means for sailors to gauge wind speeds through visual observations of the sea state. The scale runs from 0 for calm to force 12 for Hurricane. In addition, this specific measure results from technological limitations of the sonobuoy array in higher sea states and is not intended as a measure for minimizing potential effects on the marine environment.

Virginia Capes Range Complex: Historically Firing Exercise using IMPASS occured in two areas in the Virginia Capes Study Area: the adjacent Areas of 1C1/2, 7C/D & 8C/D, and a separate area to the southeast, Area 5C/D. The locations were established to be far enough from shore to reduce civilian encounters (e.g., diving and recreational fishing), while remaining a reasonable day's distance from the homeport of Norfolk, Virginia of participating ships. Surface ships conducting Firing Exercise with IMPASS do not have strict distance from land restrictions like aircraft that embark from shore-based facilities.

Jacksonville Range Complex: In accordance with the National Marine Fisheries Service's 1997 Biological Opinion issued in (NMFS 1997), the Navy has been conducting Firing Exercise using IMPASS in one location in the Jacksonville Study Area: Areas AA, BB and CC, which are adjacent to one another. Under the Biological Opinion, explosive ordnance could be used only in Areas BB and CC during non-North Atlantic right whale calving season. Recent explosive and non-explosive ordnance exposure analysis concluded there is no seasonal difference in exposure for the North Atlantic right whale between any of the gunnery boxes because there is no difference in densities between these areas; therefore, the restriction on the use of Area AA is unnecessary during calving season. Regardless, Area AA would continue to be restricted during North Atlantic right whale calving season to avoid proximity to North Atlantic right whale critical habitat. This restriction is operationally feasible because the additional steaming time from the homeport of ships conducting Firing Exercise with IMPASS (*e.g*. Naval Station Mayport, Florida) is not significantly greater than the steaming time required to reach Area AA. Further, surface ships conducting Firing Exercises using IMPASS do not have strict distance from land restrictions like those imposed on aircraft that embark from shore-based facilities.

The Navy has also proposed conducting Firing exercises with IMPASS using explosive ordnance in its JAX Deepwater IMPASS site. This site is further offshore than areas BB and CC and the Navy proposes to split the activities between BB/CC (five exercises) and the deepwater site (five exercises). The Navy anticipates that the Deepwater site will be used the remainder of the 5-year MMPA authorization. Recent ordnance exposure analysis concluded there is no difference in exposure for the North Atlantic right whale or any other large whales.

6. Surface-to-Air Gunnery (up to and including 5-inch explosive rounds) - Virginia Capes and Jacksonville Only

6.1. Vessels will orient the geometry of gunnery exercises to prevent debris from falling in the area of sighted marine mammals, sea turtles, algal mats, *Sargassum* rafts, and coral reefs.

6.2. Vessels will expedite recovery of any parachute deploying aerial targets to reduce the potential for entanglement of marine mammals and sea turtles.

6.3. If applicable, target towing aircraft shall maintain visual observation. If a marine mammal or sea turtle is sighted within the vicinity of the exercise, the tow aircraft will immediately notify the firing vessel in order to secure gunnery firing until the area is clear.

7. Surface-to-Air Gunnery (up to and including 5-inch non-explosive rounds) - Virginia Capes and Jacksonville Only

7.1. Vessels will orient the geometry of gunnery exercises in order to prevent debris from falling in the area of sighted marine mammals, sea turtles, algal mats, *Sargassum* rafts and coral reefs.

7.2. Vessels will expedite the recovery of any parachute deploying aerial targets to reduce the potential for entanglement of marine mammals and sea turtles.

7.3. If applicable, target towing aircraft shall maintain visual observation. If a marine mammal or sea turtle is sighted in the vicinity of the exercise, the tow aircraft will immediately notify the firing vessel in order to stop gunnery firing until the area is clear.

8. Small Arms Training – (such as 9 mm, .45 cal pistol, 12GA Shotgun, 5.56 mm, 7.62 mm, and .50 cal) Lookouts will visually survey for floating weeds, algal mats, *Sargassum* rafts, marine mammals, and sea turtles. Weapons will not be fired in the direction of known or observed floating weeds, algal mats, *Sargassum* rafts, marine mammals, sea turtles or coral reefs.

9. Small Arms Training – Explosive Hand Grenades (*e.g.* MK3A2 grenades) - Jacksonville Only

9.1. Lookouts will visually survey for floating weeds, algal mats, *Sargassum* rafts, marine mammals, and sea turtles.

9.2. A 200 yard (182 m) radius buffer zone will be established around the intended target. The exercises will be conducted only if the buffer is clear of sighted marine mammals and sea turtles.

10. Air-to-Surface At-Sea Bombing Exercises (250-lbs to 2,000-lbs explosive bombs) - Virginia Capes Only

This activity occurs in 7D and part of 8C in the Virginia Capes Study Area. The location was established to be far enough from shore to reduce civilian encounters (e.g., diving and recreational fishing), while remaining within 150 nm from shore-based facilities (the established flight distance restriction for F-A18 jets during unit level training events).

10.1. Aircraft will visually survey the target and buffer zone for marine mammals and sea turtles prior to and during the exercise. The survey of the impact area will be made by flying at 1,500 ft altitude or lower, if safe to do so, and at the slowest safe speed. Release of ordnance through cloud cover is prohibited: aircraft must be able to actually see ordnance impact areas. Survey aircraft should employ most effective search tactics and capabilities.

10.2. A buffer zone of 5,100-yd (4,663 m) radius will be established around the intended target zone. The exercises will be conducted only if the buffer zone is clear of sighted marine mammals and sea turtles.

10.3. If surface vessels are involved, lookouts will survey for *Sargassum* rafts. Ordnance shall not be targeted to impact within 5,100 yards (4,663 m) of known or observed *Sargassum* rafts or coral reefs.

10.4. At-sea Bombing Exercises using live ordnance will occur during daylight hours only.

11. Air-to-Surface At-Sea Bombing Exercises (non-explosive munitions)

11.1. If surface vessels are involved, trained lookouts will survey for *Sargassum* rafts, which may be inhabited by immature sea turtles, and for sea turtles and marine mammals. Ordnance shall not be targeted to impact within 1,000 yards (914 m) of known or observed *Sargassum* Rafts, sea turtles, marine mammals or coral reefs.

11.2. A 1,000 yard (914 m) radius buffer zone will be established around the intended target.

11.3. Aircraft will visually survey the target and buffer zone for marine mammals and sea turtles prior to and during the exercise. The survey of the impact area will be made by flying at 1,500 feet or lower, if safe to do so, and at the slowest safe speed. Release of ordnance through cloud cover is prohibited: aircraft must be able to actually see ordnance impact areas. Survey aircraft should employ most effective search tactics and capabilities.

11.4. The exercise will be conducted only if marine mammals and sea turtles are not visible within the buffer zone.

Jacksonville Range Complex. Releases of inert ordnance within 2 nm of North Atlantic right whales is prohibited. The term “inert ordnance” means ordnance that is not configured to explode. This term includes ordnance that carries an explosive charge, but has not been armed or fused to detonate.

12. Air-to-Surface Gunnery (such as 0.5 cal, 20 mm and 25 mm explosive or non-explosive rounds)

12.1. If surface vessels are involved, lookouts will visually survey for *Sargassum* rafts, which may be inhabited by immature sea turtles, in the target area. Impact should not occur within 200 yards (182 m) of known or observed floating weeds, algal mats, *Sargassum* rafts, or coral reefs.

12.2. A 200 yard (182 m) radius buffer zone will be established around the intended target.

12.3. If surface vessels are involved, lookout(s) will visually survey the buffer zone for marine mammals and sea turtles prior to and during the exercise.

12.4. Aerial surveillance of the buffer zone for marine mammals and sea turtles will be conducted prior to commencement of the exercise. Aerial surveillance altitude of 500 feet to 1,500 feet is optimum. Aircraft crew/pilot will maintain visual watch during exercises. Firing through cloud cover is prohibited; aircraft must be able to actually see ordnance impact areas.

12.5. The exercise will be conducted only if marine mammals and sea turtles are not visible within the buffer zone.

12.6 .If applicable, target towing control craft shall maintain a lookout. If a marine mammal or sea turtle is sighted in the vicinity of the exercise, the towing control craft will immediately notify the firing vessel in order to stop gunnery firing until the area is clear.

13. Air-to-Surface Missile Exercises (explosive)

13.1. Ordnance shall not be targeted to impact within 1,800 yd (1,646 m) of known or observed *Sargassum* rafts, which may be inhabited by immature sea turtles, or coral reefs.

13.2. Aircraft will visually survey the target area for marine mammals and sea turtles. Visual inspection of the target area will be made by flying at 1,500 ft altitude or lower, if safe to do so, and at slowest safe speed. Firing or range clearance aircraft must be able to actually see ordnance impact areas. Explosive ordnance shall not be targeted to impact within 1,800 yd (1,646 m) of sighted marine mammals and sea turtles.

Virginia Capes Range Complex. This activity has historically occurred within W-386 (Air-E, F, I, J and Air-K) and W-72A. These locations were established to be far enough from shore to reduce civilian encounters (e.g., diving and recreational fishing), while remaining within 60 nm from shore-based facilities (the established flight distance restriction for helicopters during unit level training events).

Cherry Point Range Complex. Aircraft may only conduct this exercise in Air 16 and 17 of W-122.

Jacksonville Range Complex. This activity has historically occurred in the Missile Laser Training Range. This location was established to be far enough from shore to reduce civilian encounters (*e.g.*, diving and recreational fishing), while remaining within 60 nm from shore-based facilities (the established flight distance restriction for helicopters during unit level training events).

14. Air-to-Surface Missile Exercises (non-explosive munitions) - Virginia Capes Only

14.1. Ordnance shall not be targeted to impact within 1,800 yards (1646 m) of known or observed *Sargassum* rafts, which may be inhabited by immature sea turtles, or coral reefs.

14.2..Aircraft will visually survey the target area for marine mammals and sea turtles. Visual inspection of the target area will be made by flying at 1,500 feet or lower, if safe to do so, and at slowest safe speed. Firing or range clearance aircraft must be able to actually see ordnance impact areas. Ordnance shall not be targeted to impact within 1,800 yards (1,646 m) of sighted marine mammals and sea turtles.

14.3. This activity will only occur in W-386 (Air-K).

15. Air-to-Air Missile Exercises (explosive and non-explosive)

The geometry of missile exercises will be oriented in order to minimize the potential for debris to fall within 1,000 yards (914 m) of sighted marine mammals, sea turtles, algal mats, *Sargassum* rafts, and coral reefs.

16. Mine Neutralization Training Involving Underwater Detonations (up to and including 20-lbs Net Explosive Weight charges)

16.1. Mine neutralization involving underwater detonations occurs in shallow water (0-120 ft or 0-36 m) and is executed by divers using scuba. The NMFS’ 2002 Biological Opinion addressed underwater detonations of up to and including 20-lb explosive charges related to Mine Neutralization training (NMFS 2002). These exercises utilize small boats that deploy from shore-based facilities. Often times these small boats are rigid-hulled inflatable boats which are designed for shallow water and have limited seaworthiness necessitating a nearshore location. The exercise is a one-day event that occurs only during daylight hours therefore the distance from shore is limited.

16.2. Observers will survey the buffer zone, a 700 yd (640 m) radius from detonation location, for marine mammals and sea turtles from all participating vessels during the entire operation. A survey of the buffer zone (minimum of 3 parallel tracklines 219 yd (200 m) apart) using support craft will be conducted at the detonation location 30 minutes prior through 30 minutes post detonation. During late July through October, an additional surface observer will be added to more carefully look for hatchling turtles in the buffer zone. Aerial survey support will be utilized whenever assets are available.

16.3. Detonation operations will be conducted during daylight hours.

16.4. If a sea turtle or marine mammal is sighted within the buffer zone, the animal will be allowed to leave of its own volition. The Navy will suspend detonation exercises and ensure the area is clear for a full 30 minutes prior to detonation.

16.5. Divers placing the charges on mines and dive support vessel personnel will survey the area for sea turtles and marine mammals and will report any sightings to the surface observers. These animals will be allowed to leave of their own volition and the buffer zone will be clear for 30 minutes prior to detonation.

16.6. No detonations will take place within 3.2 nm of an estuarine inlet (*e.g.*, Chesapeake Bay).

16.7. No detonations will take place within 1.6 nm of shoreline.

16.8. No detonations will take place within 1,000 ft of any known artificial reef, shipwreck, or live hard-bottom community.

16.9. Personnel will record any protected species observations during the exercise as well as measures taken if species are detected within the buffer zone.

Virginia Capes Range Complex: Historically this activity has occurred in shallow water portions of W-50 in the Virginia Capes Study Area per NMFS' 2002 biological opinion. This location is just offshore from NAS Oceana Dam Neck Annex, a restricted-access Naval Installation and overlaps an established Surface Danger Zone for live ordnance use, therefore civilian encounters are minimized. This location has a low bathymetric relief and a sand-silt bottom. This activity will only occur in W-50.

Cherry Point Range Complex: Divers may only conduct underwater detonations in the designated Mine Neutralization Box of Area 15 within the Cherry Point Operating Area.

Jacksonville Range Complex: This activity will occur in two locations: Underwater Detonation North (10L) and Underwater Detonation South (12I). These locations are offshore from Naval Weapons Station Charleston, South Carolina, a restricted-access Naval installation. There locations have low bathymetric relief and a sand-silt bottom.

17. Mine Countermeasures – Minesweeping Using Equipment Towed by Helicopters

17.1. Use trained lookouts to survey for *Sargassum* rafts, sea turtles and marine mammals prior to and during the exercise.

17.2. Establish a 250 yard (229 m) buffer zone around the towed equipment. Exercise will not be conducted if marine mammals or sea turtles are detected within the buffer zone.

18. Inert Mine Shape Deployment

18.1. Known shipwrecks will be avoided when deploying inert mine shapes.

18.2. Known artificial and oyster reefs will be avoided when deploying inert mine shapes.

19. Anchorage of Ships

19.1. These requirements are not applicable if going to an assigned anchorage.

19.2. Avoid *Sargassum* rafts.

19.3. Ships will not anchor in the vicinity of coral reefs, except in designated anchorages or for safety of ship: vicinity is defined as the anchor swing circle encompassing a portion of a coral reef.

19.4. Ships will not anchor in areas of known shipwrecks.

1.7 Mitigation and Monitoring Required by NMFS' Permits Division

NMFS' Permits Division is proposing to issue Letters of Authorization to allow the U.S. Navy to "take" marine mammals incidental to training operations occurring in the Virginia Capes Range Complex, Cherry Point Range Complex, and Jacksonville Range Complex. Each LOA requires the U.S. Navy to implement the same general mitigation measures, monitoring activities and reporting requirements, although there are some differences between the three range complexes that reflect differences in their geography and the training activities that would occur on them. The following narrative describes the mitigation, monitoring, and reporting requirements contained in the LOAs for the Virginia Capes Range Complex; to preserve space, we follow that presentation with an explanation of how the mitigation, monitoring, and reporting requirements contained in the regulations for Cherry Point and Jacksonville Range Complex differ from those required for the Virginia Capes Range Complex.

(1) General Maritime Measures:

(i) Personnel Training – Lookouts

(A) All bridge personnel, Commanding Officers, Executive Officers, officers standing watch on the bridge, maritime patrol aircraft aircrews, and Mine Warfare (MIW) helicopter crews will complete Marine Species Awareness Training (MSAT).

(B) Navy lookouts will undertake extensive training to qualify as a watchstander in accordance with the Lookout Training Handbook (NAVEDTRA 12968-D).

(C) Lookout training will include on-the-job instruction under the supervision of a qualified, experienced watchstander. Following successful completion of this supervised training period, lookouts will complete the Personal Qualification Standard Program, certifying that they have demonstrated the necessary skills (such as detection and reporting of partially submerged objects).

(D) Lookouts will be trained in the most effective means to ensure quick and effective communication within the command structure to facilitate implementation of protective measures if marine species are spotted.

(E) Surface lookouts would scan the water from the ship to the horizon and be responsible for all contacts in their sector. In searching the assigned sector, the lookout would always start at the forward part of the sector and search aft (toward the back). To search and scan, the lookout would hold the binoculars steady so the horizon is in the top third of the field of vision and direct the eyes just below the horizon. The lookout would scan for approximately five seconds in as many small steps as possible across the field seen through the binoculars. They would search the entire sector in approximately five-degree steps, pausing between steps for approximately five seconds to scan the field of view. At the end of the sector search, the glasses would be lowered to allow the eyes to rest for a few seconds, and then the lookout would search back across the sector with the naked eye.

(F) At night, lookouts shall scan the horizon in a series of movements that would allow their eyes to come to periodic rests as they scan the sector. When visually searching at night, they shall look a little to one side and out of the corners of their eyes, paying attention to the things on the outer edges of their field of vision. Lookouts shall also have night vision devices available for use.

(ii) Operating Procedures & Collision Avoidance

(A) Prior to major exercises, a Letter of Instruction, Mitigation Measures Message or Environmental Annex to the Operational Order will be issued to further disseminate the personnel training requirement and general marine species mitigation measures.

(B) Commanding Officers will make use of marine species detection cues and information to limit interaction with marine species to the maximum extent possible consistent with safety of the ship.

(C) While underway, surface vessels will have at least two lookouts with binoculars; surfaced submarines will have at least one lookout with binoculars. Lookouts already posted for safety of navigation and man-overboard precautions may be used to fill this requirement. As part of their regular duties, lookouts will watch for and report to the OOD the presence of marine mammals.

(D) Personnel on lookout will employ visual search procedures employing a scanning method in accordance with the Lookout Training Handbook (NAVEDTRA 12968-D).

(E) After sunset and prior to sunrise, lookouts will employ Night Lookouts Techniques in accordance with the Lookout Training Handbook (NAVEDTRA 12968-D).

(F) While in transit, naval vessels will be alert at all times, use extreme caution, and proceed at a “safe speed” so that the vessel can take proper and effective action to avoid a collision with any marine animal and can be stopped within a distance appropriate to the prevailing circumstances and conditions.

(G) When whales have been sighted in the area, Navy vessels will increase vigilance and implement measures to avoid collisions with marine mammals and avoid activities that might result in close interaction of naval assets and marine mammals. Such measures shall include changing speed and/or direction and would be dictated by environmental and other conditions (e.g., safety or weather).

(H) Naval vessels will maneuver to keep at least 500 yds (460 m) away from any observed whale and avoid approaching whales head-on. This requirement does not apply if a vessel's safety is threatened, such as when change of course will create an imminent and serious threat to a person, vessel, or aircraft, and to the extent vessels are restricted in their ability to maneuver. Vessels shall take reasonable steps to alert other vessels in the vicinity of the whale.

(I) Where feasible and consistent with mission and safety, vessels will avoid closing to within 200-yd (183 m) of marine mammals other than whales (whales addressed above).

(J) Navy aircraft participating in exercises at sea will conduct and maintain, when operationally feasible and safe, surveillance for marine species of concern as long as it does not violate safety constraints or interfere with the accomplishment of primary operational duties. Marine mammal detections will be immediately reported to assigned Aircraft Control Unit for further dissemination to ships in the vicinity of the marine species as appropriate where it is reasonable to conclude that the course of the ship will likely result in a closing of the distance to the detected marine mammal.

(K) All vessels shall maintain logs and records documenting training operations should they be required for event reconstruction purposes. Logs and records will be kept for a period of 30 days following completion of a major training exercise.

(2) Coordination and Reporting Requirements

(i) The Navy shall coordinate with the local NMFS Stranding Coordinator for any unusual marine mammal behavior and any stranding, beached live/dead, or floating marine mammals that may occur at any time during or within 24 hours after completion of training activities.

(ii) The Navy shall follow internal chain of command reporting procedures as promulgated through Navy instructions and orders.

(3) Mitigation Measures Applicable to Vessel Transit in the Mid-Atlantic during North Atlantic Right Whale Migration:

(i) Mid-Atlantic, Offshore of the Eastern United States: The mitigation measures apply to all Navy vessel transits, including those vessels that would transit to and from East Coast ports and OPAREAs.

(A) All Navy vessels are required to use extreme caution and operate at a slow, safe speed consistent with mission and safety (at a speed that does not compromise navigation safety) during the months indicated below and within a 37 km (20 nm) arc (except as noted) of the specified associated reference points:

(1) South and East of Block Island (37 km (20 NM) seaward of line between 41-4.49° N. lat. 071-51.15 ° W. long. and 41-18.58 ° N. lat. 070-50.23° W. long):Sept-Oct and Mar-Apr

(2) New York / New Jersey (40-30.64 ° N. lat. 073-57.76 ° W. long.): Sep–Oct and Feb-Apr.

(3) Delaware Bay (Philadelphia) (38-52.13° N. lat. 075-1.93 ° W. long.): Oct–Dec and Feb–Mar.

(4) Chesapeake Bay (Hampton Roads and Baltimore) (37-1.11 ° N. lat. 075-57.56 ° W. long.): Nov-Dec and Feb–Apr.

(5) North Carolina (34-41.54 ° N. lat. 076-40.20 ° W. long.): Dec-Apr

(6) South Carolina (33-11.84 ° N. lat. 079-8.99 ° W. long. and 32-43.39 ° N. lat. 079-48.72 ° W. long.): Oct-Apr

(B) During the months indicated above for mitigation measures applicable to Navy vessel transits in the Mid-Atlantic (paragraph (a)(3)(i)(A) of this section), Navy vessels shall practice increased vigilance with respect to avoidance of vessel-whale interactions along the mid-Atlantic coast, including transits to and from any mid-Atlantic ports not specifically identified in paragraph (a)(3)(i)(A) of this section.

(C) All surface units transiting within 56 km (30 NM) of the coast in the mid-Atlantic shall ensure at least two watchstanders are posted, including at least one lookout who has completed required MSAT training.

(D) Navy vessels shall not knowingly approach any whale head on and shall maneuver to keep at least 457 m (1,500 ft) away from any observed whale, consistent with vessel safety.

(ii) Southeast Atlantic, Offshore of the Eastern United States – for the purposes of the measures below, the "southeast" encompasses sea space from Charleston, South Carolina, southward to Sebastian Inlet, Florida, and from the coast seaward to 148 km (80 NM) from shore. North Atlantic right whale critical habitat is the area from 31-15 ° N. lat. to 30-15 ° N. lat. extending from the coast out to 28 km (15 NM), and the area from 28-00 ° N. lat. to 30-15 ° N. lat. from the coast out to 9 km (5 NM). All mitigation measures described here that apply to the critical habitat apply from November 15 – April 15 and also apply to an associated area of concern which extends 9 km (5 NM) seaward of the designated critical habitat boundaries.

(A) Prior to transiting or training in the critical habitat or associated area of concern, ships shall contact Fleet Area Control and Surveillance Facility, Jacksonville, to obtain latest whale sighting and other information needed to make informed decisions regarding safe speed (the minimum speed at which mission goals or safety will not be compromised) and path of intended movement. Subs shall contact Commander, Submarine Group Ten for similar information.

(B) The following specific mitigation measures apply to activities occurring within the North Atlantic right whale critical habitat and an associated area of concern which extends 9 km (5 NM) seaward of the designated critical habitat boundaries:

(1) When transiting within the critical habitat or associated area of concern, 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 whale is sighted by a vessel or when the vessel is within 9 km (5 NM) of a reported new sighting less than 12 hours old. Circumstances could arise where, in order to avoid North Atlantic right whale(s), speed reductions could mean vessel must reduce speed to a minimum at which it can safely keep on course or vessels could come to an all stop.

(3) Vessels shall avoid head-on approaches to North Atlantic right whale(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 the ability to maneuver.

(4) During the North Atlantic right whale calving season, north-south transits through the critical habitat are prohibited.

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

(iii) Northeast Atlantic, Offshore of the Eastern United States:

Prior to transiting the Great South Channel or Cape Cod Bay critical habitat areas, ships shall obtain the latest North Atlantic right whale sightings and other information needed to make informed decisions regarding safe speed (the minimum speed at which mission goals or safety will not be compromised). The Great South Channel critical habitat is defined by the following coordinates: 41^{o}40N, 69^{o} 45W; 41^{o}00N, 69^{o}05W; 41^{o}38N, 68^{o}13W; 42^{o}10N, 68^{o}31W. The Cape Cod Bay critical habitat is defined by the following coordinates: 42^{o}04.8N, 70^{o}10W; 42^{o} 12N, 70^{o}15W; 42^{o}12N, 70^{o} 30W; 41^{o} 46.8N, 70^{o}30W.

(B) Ships, surfaced subs, and aircraft shall report any North Atlantic right whale sightings (if the whale is identifiable as a right whale) off the northeastern U.S. to Patrol and Reconnaissance Wing (COMPATRECONWING). The report shall include the time of sighting, lat/long, direction of movement (if apparent) and number and description of the whale(s).

(C) Vessels or aircraft that observe whale carcasses shall record the location and time of the sighting and report this information as soon as possible to the cognizant regional environmental coordinator. All whale strikes must be reported. This report shall include the date, time, and location of the strike; vessel course and speed; operations being conducted by the vessel; weather conditions, visibility, and sea state; description of the Whale; narrative of incident; and indication of whether photos/videos were taken. Navy personnel are encouraged to take photos whenever possible.

(D) Specific mitigation measures related to activities occurring within the critical habitat include the following:

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

(2) When transiting within the critical habitat or associated area of concern, vessels shall use extreme caution and operate at a safe speed (the minimum speed at which mission goals or safety will not be compromised) so as to be able to avoid collisions with North Atlantic right whales and other marine mammals, and stop within a distance appropriate to the circumstances and conditions.

(3) Speed reductions (adjustments) are required when a whale is sighted by a vessel or when the vessel is within 9 km (5 NM) of a reported new sighting less than one week old.

(4) Ships transiting in the Cape Cod Bay and Great South Channel critical habitats shall obtain information on recent whale sightings in the vicinity of the critical habitat. Any vessel operating in the vicinity of a North Atlantic right whale shall consider additional speed reductions as per Rule 6 of International Navigational Rules.

(4) Proposed Mitigation Measures for Specific At-sea Training Events – If a marine mammal is killed as a result of the proposed Navy training activities (e.g., instances in which it is clear that munition explosions caused the death), the Navy shall suspend its activities immediately and report such incident to NMFS.

(i) Firing Exercise (FIREX) Using the Integrated Maritime Portable Acoustic Scoring System (IMPASS) (5-in. Explosive Rounds)

(A) In the VACAPES Range Complex FIREX with IMPASS would only be conducted in the four designated areas specified in the Navy’s LOA application for the VACAPES Range Complex.

(B) In the Jacksonville Range Complex FIREX with IMPASS would only be conducted in areas BB, CC and the JAX Deepwater IMPASS site

(C) During North Atlantic right whale calving season no explosive ordnance shall be used in Areas BB and CC.

(D) Pre-exercise monitoring of the target area shall be conducted with “Big Eyes” prior to the event, during deployment of the IMPASS sonobuoy array, and during return to the firing position. Ships will be required to maintain a lookout dedicated to visually searching for marine mammals 180^{o} along the ship track line and 360^{o} at each buoy drop-off location.

(E) “Big Eyes” on the ship shall be used to monitor a 600 yd (548 m) buffer zone around the target area for marine mammals during naval-gunfire events.

(F) Ships shall not fire on the target if any marine mammals are detected within or approaching the 600 yd (548 m) until the area is cleared. If marine mammals are present, operations shall be suspended. Visual observation shall occur for approximately 45 minutes, or until the animal has been observed to have cleared the area and is heading away from the buffer zone.

(G) Post-exercise monitoring of the entire target area shall take place with “Big Eyes” and the naked eye during the retrieval of the IMPASS sonobuoy array following each firing exercise.

(H) FIREX with IMPASS shall take place during daylight hours only.

(I) FIREX with IMPASS shall only be used in Beaufort Sea State three (3) or less.

(J) The visibility must be such that the fall of shot is visible from the firing ship during the exercise.

(K) No firing shall occur if marine mammals are detected within 70 yd (64 m) of the vessel.

(ii) Air-to-Surface At-Sea Bombing Exercises (250-lbs to 2,000-lbs explosive bombs)

(A) Aircraft shall visually survey the target and buffer zone for marine mammals prior to and during the exercise. The survey of the impact area will be made by flying at 1,500 ft (457 m) altitude or lower, if safe to do so, and at the slowest safe speed.

(B) A buffer zone of 5,100-yd (4,663 m) radius shall be established around the intended target zone. The exercises shall be conducted only when marine mammals are observed to be outside the buffer zone.

(C) At-sea BOMBEXs using live ordnance shall occur during daylight hours only.

(iii) Air-to-Surface Missile Exercises (Explosive)

(A) Aircraft shall initially survey the intended ordnance impact area for marine mammals.

(B) During the actual firing of the weapon, the aircraft involved must be able to observe the intended ordnance impact area to ensure the area is free of marine mammals transiting the range.

(C) Visual inspection of the target area shall be made by flying at 1,500 ft (457 m) altitude or lower, if safe to do so, and at slowest safe speed.

(D) Explosive ordnance shall not be targeted to impact within 1,800 yd (1,646 m) of sighted marine mammals.

(iv) Mine Neutralization Training Involving Underwater Detonations (up to 20-lb charges)

(A) This activity shall only occur in W-50 of the VACAPES Range Complex.

(B) Observers shall survey the Zone of Influence (ZOI), a 700 yd (640 m) radius from detonation location for marine mammals from all participating vessels during the entire operation. A survey of the ZOI (minimum of 3 parallel tracklines 219 yd [200 m] apart) using support craft shall be conducted at the detonation location 30 minutes prior through 30 minutes post detonation. Aerial survey support shall be utilized whenever assets are available.

(C) Detonation operations shall be conducted during daylight hours only.

(D) If a marine mammal is sighted within the ZOI, the animal shall be allowed to leave of its own volition. The Navy shall suspend detonation exercises and ensure the area is clear of marine mammals for a full 30 minutes prior to detonation.

(E) No detonations shall be conducted using time-delay devices.

(F) Divers placing the charges on mines and dive support vessel personnel shall survey the area for marine mammals and shall report any sightings to the surface observers. These animals shall be allowed to leave of their own volition and the ZOI shall be clear of marine mammals for 30 minutes prior to detonation.

(G) No detonations shall take place within 3.2 nm (6 km) of an estuarine inlet (Chesapeake Bay Inlets).

(H) No detonations shall take place within 1.6 nm (3 km) of shoreline.

(I) Personnel shall record any protected species observations during the exercise as well as measures taken if species are detected within the ZOI.

Monitoring and Reporting

(a) The U.S. Navy must notify NMFS immediately (or as soon as clearance procedures allow) if the specified activity identified in 50 C.F.R. § 218.1(c) is thought to have resulted in the mortality or injury of any marine mammals, or in any take of marine mammals not identified in 50 C.F.R. § 218.2(c).

(b) The Navy must conduct all monitoring and required reporting under the Letter of Authorization, including abiding by the VACAPES Range Complex Monitoring Plan, which is incorporated herein by reference, and which requires the Navy to implement, at a minimum, the monitoring activities summarized below.

(1) Vessel or aerial surveys.

(i) The U.S. Navy shall visually survey a minimum of 2 explosive events per year, one of which shall be a multiple detonation event. One of the vessel or aerial surveys should involve professionally trained marine mammal observers (MMOs). If it is impossible to conduct the required surveys due to the lack of training exercises, the missed annual survey requirement shall roll into the subsequent year to ensure that the appropriate number of surveys occurs over the 5-year period of effectiveness of 50 C.F.R. Part 218, Subpart B.

(ii) Where operationally feasible, for specified training events, aerial or vessel surveys shall be used 1-2 days prior to, during (if reasonably safe), and 1-5 days post detonation.

(iii) Surveys shall include any specified exclusion zone around a particular detonation point plus 2,000 yards beyond the border of the exclusion zone (i.e., the circumference of the area from the border of the exclusion zone extending 2,000 yards outwards). For vessel based surveys a passive acoustic system (hydrophone or towed array) could be used to determine if marine mammals are in the area before and/or after a detonation event.

(iv) When conducting a particular survey, the survey team shall collect:

(A) Location of sighting;

(B) Species (if not possible, indicate whale, dolphin or pinniped);

(C) Number of individuals;

(D) Whether calves were observed;

(E) Initial detection sensor;

(F) Length of time observers maintained visual contact with marine mammal;

(G) Wave height;

(H) Visibility;

(I) Whether sighting was before, during, or after detonations/exercise, and how many minutes before or after;

(J) Distance of marine mammal from actual detonations (or target spot if not yet detonated);

(K) 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 animal closing to bow ride, paralleling course/speed, floating on surface and not swimming etc.), including speed and direction;

(L) Resulting mitigation implementation - Indicate whether explosive detonations were delayed, ceased, modified, or not modified due to marine mammal presence and for how long; and

(M) If observation occurs while explosives are detonating in the water, indicate munition type in use at time of marine mammal detection.

(2) Passive acoustic monitoring

(i) Any time a towed hydrophone array is employed during shipboard surveys the towed array shall be deployed during daylight hours for each of the days the ship is at sea.

(ii) The towed hydrophone array shall be used to supplement the ship-based systematic line-transect surveys (particularly for species such as beaked whales that are rarely seen).

(iii) The array shall have the capability of detecting low frequency vocalizations for baleen whales (<1,000 kHz) and relatively high frequency (up to 30 kHz) for odontocetes. The use of two simultaneously deployed arrays can also allow more accurate localization and determination of diving patterns.

(3) Marine mammal observers on Navy platforms

(i) As required in 50 C.F.R. § 218.5(c)(1), MMOs selected for aerial or vessel survey shall be placed on a Navy platform during one of the explosive exercises being monitored per year, the other designated exercise shall be monitored by the Navy lookouts/watchstanders.

(ii) The MMO must possess expertise in species identification of regional marine mammal species and experience collecting behavioral data.

(iii) MMOs shall not be placed aboard Navy platforms for every Navy training event or major exercise, but during specifically identified opportunities deemed appropriate for data collection efforts. The events selected for MMO participation shall take into account safety, logistics, and operational concerns.

(iv) MMOs shall observe from the same height above water as the lookouts.

(v) The MMOs shall not be part of the Navy's formal reporting chain of command during their data collection efforts; Navy lookouts shall continue to serve as the primary reporting means within the Navy chain of command for marine mammal sightings. The only exception is that if an animal is observed within the shutdown zone that has not been observed by the lookout, the MMO shall inform the lookout of the sighting and the lookout shall take the appropriate action through the chain of command.

(vi) The MMOs shall collect species identification, behavior, direction of travel relative to the Navy platform, and distance first observed. Information collected by MMOs be the same as those collected by Navy lookout/watchstanders described in 50 C.F.R. § 218.5(c)(1)(iv).

(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, any Navy training exercise utilizing underwater explosive detonations. 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 is dead), location, time of first discovery, observed behaviors (if alive), and photo or video (if available).

(d) Annual VACAPES Range Complex Monitoring Plan Report - The Navy shall submit a report annually on March 1 describing the implementation and results (through January 1 of the same year) of the VACAPES Range Complex Monitoring Plan. Data collection methods will be standardized across range complexes to allow for comparison in different geographic locations. Although additional information will also be gathered, the MMOs collecting marine mammal data pursuant to the VACAPES Range Complex Monitoring Plan shall, at a minimum, provide the same marine mammal observation data required in the data required in 50 C.F.R. §218.5(g). The VACAPES Range Complex Monitoring Plan Report may be provided to NMFS within a larger report that includes the required Monitoring Plan Reports from VACAPES Range Complex and multiple range complexes.

(e) Annual VACAPES Range Complex Exercise Report - The Navy shall provide the information described below for all of their explosive exercises. Until the Navy is able to report in full the information below, they shall provide an annual update on the Navy‘s explosive tracking methods, including improvements from the previous year.

(1) Total annual number of each type of explosive exercise (of those identified as part of the “specified activity” in the LOA) conducted in the VACAPES Range Complex.

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

(f) The Navy shall respond to NMFS’ comments and requests for additional information or clarification on the VACAPES Range Complex Comprehensive Report, the Annual VACAPES Range Complex Exercise Report, or the Annual VACAPES Range Complex Monitoring Plan Report (or the multi-Range Complex Annual Monitoring Plan Report, if that is how the Navy chooses to submit the information) if submitted within 3 months of receipt. These reports will be considered final after the Navy has addressed NMFS’ comments or provided the requested information, or three months after the submittal of the draft if NMFS does not comment by then.

Mitigation, Monitoring, and Reporting for the Cherry Point Range Complex

The proposed 2011 LOA for the Cherry Point Range Complex require the U.S. Navy to implement the same general mitigation measures (particularly those that are applicable to endangered or threatened species), engage in monitoring activities, and comply with reporting requirements that are the same, in most respects, as the mitigation, monitoring, and reporting requirements contained in the proposed 2011 LOA for the Virginia Capes Range Complex; however, the proposed 2011 LOA for the Cherry Point Range Complex does not contain a mitigation requirement for Air-to-Surface Bombing Exercises (Item 6(d)(ii) of the 2011 LOA for the Virginia Capes Range Complex), does not contain a requirement for ships not to transit through designated critical habitat or an associated area of concern in a north-south direction during the calving season for North Atlantic right whales (Item 6(c)(ii)(B)(4) in the proposed

Letter of Authorization for the Virginia Capes Range Complex), or a reference to Chesapeake Bay inlets in reference to mine neutralization activities (Item 6(iv)(G) in the proposed 2011 Letter of Authorization for the Virginia Capes Range Complex).

Mitigation, Monitoring, and Reporting for the Jacksonville Range Complex

The proposed 2011 LOA for the Jacksonville Range Complex requires the U.S. Navy to implement the same general mitigation measures (particularly those that are applicable to endangered or threatened species), engage in monitoring activities, and comply with reporting requirements that are , in most respects, as the mitigation, monitoring, and reporting requirements contained in the proposed 2010 LOA for the Virginia Capes Range Complex, although there are some differences in the strength of the mandate, the proposed 2010 LOA for the Jacksonville Range Complex does not contain a mitigation requirement for Air-to-Surface Bombing Exercises (Item 6(d)(ii) in the proposed 2011 LOA for the Virginia Capes Range Complex). or a reference to Chesapeake Bay inlets in reference to mine neutralization activities (Item 6(iv)(G) in the proposed 2011 LOA for the Virginia Capes Range Complex).

1.8 Interrelated and Interdependent Actions

The section 7 regulations (50 CFR 402.02 and 402.14) require us to assess the direct and indirect effects of proposed actions as well as the direct or indirect effects of other activities that are interrelated or interdependent with the action(s) we consider in a consultation. The section 7 regulations define “interrelated actions” as those actions that are part of a larger action and depend on the larger action for their justification; the regulatory definition of “interdependent actions” is those actions that have no independent utility apart from the action under consideration (50 CFR 402.02).

In our January 2009 programmatic and subsequent biological opinions on the military readiness activities the U.S. Navy proposes to conduct on the Northeast, Virginia Capes, Cherry Point, and Jacksonville Range Complexes, we identified the Atlantic Fleet Active Sonar Training (AFAST) activities as interrelated with military readiness acitivities on the three east coast range complexes. Those training activities continue to be interrelated and the AFAST activities are described immediately following this introduction (in subsection 1.8.1). In July 2009, NMFS completed a biological opinion on the proposed Undersea Warfare Training Range that the U.S. Navy plans to install in the Jacksonville Range Complex, which is interrelated to both the military readiness activities the U.S. Navy proposes to conduct on the Northeast, Virginia Capes, Cherry Point, and Jacksonville Range Complexes and the AFAST activities. We summarize activities associated with this training range after the AFAST activities (in subsection 1.8.2).

1.8.1. Atlantic Fleet Active Sonar

Many of the training activities the U.S. Navy proposes to conduct in the Northeast Operating Areas, Virginia Capes Range Complex, Cherry Point Range Complex, and Jacksonville Range Complex are interrelated with active sonar training activities the U.S. Navy conducts along the Atlantic Coast of the United States. For example, mine countermeasures training, composite training unit exercises, and joint task force exercises involve combinations of ordnance discussed earlier in this *Description of the Proposed Action* and the active sonar systems discussed in our 2009 and subsequent Opinions on the Atlantic Fleet Active Sonar Training. As a result, the active sonar training activities we considered in our 2009 and subsequent Opinions are interrelated with the proposed actions that are the primary focus of this Opinion. In fact, some of the vessels involved in these activities engage in both mine countermeasures training and employ active sonar as part of the same training activity.

NMFS considered the direct and indirect effects of the U.S. Navy's Atlantic Fleet Active Sonar Training activities in biological opinions we issued in January of 2009 and 2010. However, those training activities are interrelated with the actions we consider in this consultation because Navy training events that involve some or all of the activities considered in this opinion (gunnery exercises, missile exercises, bombing exercises, mine neutralization, mine countermeasures, etc.) would also involve the use of the active sonar or underwater detonations that were considered in our January 2009 and January 2010 Opinions on Atlantic Fleet Active Sonar Training. For example, some of the vessels involved in these activities engage in both mine countermeasures training and employ active sonar as part of the same training activity. To ensure that this Opinion and conference considers the combined direct and indirect effects of the actions we described earlier in this section as well as the active sonar and underwater detonations we considered in the earlier Opinions, we summarize the description of the Atlantic Fleet Active Sonar Training activities from our earlier Opinions (see Table 4 at the end of this section) and summarize the results of our effects analyses in this biological and conference Opinion. The action we considered in our Opinion on the Atlantic Fleet Active Sonar Training consisted of five separate but related activities that were scheduled to occur in the area identified in Figure 4 and summarized as follows:

1. the U.S. Navy's proposal to continue conducting mid- and high-frequency active sonar and improved AN/SSQ-110A), operating area that occur within the Atlantic Fleet Active Sonar Training study area, which includes areas along the Atlantic coast of the United States and within the Gulf of Mexico from January 2009 to January 2014

2. the Permits Division's issuance of regulations governing the take of marine mammals (50 CFR Part 216) to allow NMFS to issue annual letters of authorization that would allow the U.S. Navy to take marine mammals for a five-year period beginning in January 2009 and ending in January 2014 incidental to the U.S. Navy's active sonar training activities along the Atlantic Coast and the Gulf of Mexico.

3. the Permits Division's 2009 Letter of Authorization for the U.S. Navy to "take" marine mammals incidental to the conduct of active sonar training along the Atlantic Coast of the United States and in the Gulf of Mexico January 2009 to January 2010.

4.the Permits Division's 2010 Letter of Authorizationfor the U.S. Navy to take" marine mammals incidental to the conduct of active sonar training along the Atlantic Coast of the United States and in the Gulf of Mexico January 2010 to January 2011.

5. the Permits Division's 2011 Letter of Authorizationfor the U.S. Navy to "take" marine mammals incidental to the conduct of active sonar training along the Atlantic Coast of the United States and in the Gulf of Mexico January 2011 to January 2012.

1.8.1.1. Training Scenarios

The training activities considered in this Opinion result from Independent Unit Level Training (ULT; the term "units" refers to individual ships, submarines and aircraft) activities, Coordinated Unit-Level Training, Strike Group training exercises, Research, Development, Test and Evaluation, and active sonar maintenance. The following narratives summarize the different kinds of activities these training activities involve; for more detailed descriptions of these activities, readers should refer to the U.S. Navy's Final Environmental Impact Statement on Atlantic Fleet Training (Navy 2008b).

1.8.1.1.1. Independent Unit Level Training Scenarios

Independent Unit-Level training events typically last two to six hours and involve one or two ships or aircraft. Active sonar systems are typically used during only portions of these training events. The U.S. Navy plans to continue conducting about 2,400 unit-level training events each year.

Surface Ship Anti-Submarine Warfare Unit-Level Training

In this training scenario, one or two surface ships (guided missile cruisers, guided missile destroyers, or fast frigates) conduct anti-submarine warfare localization and tracking training using the AN/SQS-53, AN/SQS-56, or AN/SLQ-25 NIXIE. In addition, one MK-39 Expendable Mobile Acoustic Training Target or MK-30 target may be used as a target during an exercise. In some Surface Ship anti-submarine warfare unit-level training events a MK-1, MK-2, MK-3, MK-4, MK-46 torpedo, and a noise acoustic emitter could be used. These training exercises would generally occur in both deep and shallow water areas throughout the eastern and southeastern coast of the United States.

Surface Ship Object Detection/Navigational Unit-Level Training

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

Helicopter Anti-Submarine Warfare Unit-Level Training

In this training scenario, one SH-60 helicopter conducts anti-submarine warfare training using the AN/AQS-13 or AN/AQS-22 dipping sonar, tonal sonobuoys (e.g., AN/SSQ-62), passive sonobuoy and torpedoes. One MK-39 Expendable Mobile Acoustic Training Target or MK-30 target may also be used as a target per exercise. This activity would be conducted in shallow and deep waters while embarked on a surface ship. Helicopter anti-submarine warfare unit level training events would also be conducted by helicopters deployed from shore-based Jacksonville, Florida, units.

Submarine Anti-Submarine Warfare Unit-Level Training

This training scenario consists of one submarine conducting underwater anti-submarine warfare training using AN/BQQ-10 active sonar systems and torpedoes. In addition, an MK-39 Expendable Mobile Acoustic Training Target or MK-30 target may be used as a target. Submarines would be conducting this training in deep waters throughout the Study Area, within and seaward of existing East Coast Operating Areas and occasionally in the Gulf of Mexico Operating Area.

Submarine Object Detection/Navigational Training Unit-Level Training

In this training scenario, individual submarines conduct object detection and navigational training while transiting in and out of port using AN/BQS-15 sonar. In this training scenario, submarines would operate sonar to detect obstructions while they transit. This unit-level training occurs primarily in the established submarine transit lanes outside of Groton, Connecticut; Norfolk, Virginia; and King’s Bay, Georgia.

Maritime Patrol Aircraft Anti-Submarine Warfare Unit-Level Training

In this training scenario, individual maritime patrol aircraft conduct anti-submarine warfare localization and tracking training using tonal (AN/SSQ-62), passive (AN/SSQ-53D/E), explosive source (AN/SSQ-110A) or receiver (AN/SSQ-101) sonobuoys. Additionally, one MK-39 Expendable Mobile Acoustic Training Target or MK-30 target for each training scenario may be used as a target. Maritime Patrol Aircraft anti-submarine warfare unit-level training would occur within and seaward of existing East Coast Operating Areas and occasionally within the Gulf of Mexico Operating Area.

Surface Ship Mine Warfare Unit-Level Training

In this training scenario, individual ships would conduct mine localization training using AN/SSQ-32 and AN/SLQ-48 sonar systems. This training would be conducted in the northern Gulf of Mexico in the Gulf of Mexico Operating Areas, and off the east coast of Texas, in the Corpus Christi Operating Area.

1.8.1.1.2. Coordinated Unit Level Training

The U.S. Navy plans to continue conducting about 40 coordinated unit-level training events each year. Specific training scenarios include the following activities:

Southeastern Anti-Submarine Warfare Integrated Training Initiative

Southeastern Anti-Submarine Warfare Integrated Training Initiatives (SEASWITI) are exercises with up to two submarines and either two guided missile destroyers and one fast frigate or one guided missile cruiser, one guided missile destroyer, and one fast frigate. The ships and their embarked helicopters would be conducting ASW localization training using the AN/SQS-53, AN/SQS-56, and AN/AQS-13 or AN/AQS-22 dipping sonar. Submarine would also operate AN/BQQ-10 sonar periodically. Up to 24 tonal sonobuoys (e.g., AN/SSQ-62) and two acoustic device countermeasures would also be used in these exercises.

These training scenarios typically occur over 5- to 7-day periods and occur four times per year. This training exercise using the AN/AQS-13 or AN/AQS-22 sonar systems would occur in the deep water within or adjacent to the Jacksonville-Charleston Operating Areas. To meet the operational requirements for these exercises, the western boundary (i.e., training area entry point) of training areas must be no greater than 167 kilometers (km) and 185 km (90 nautical miles [nm] and 100 nm) from port.

Group Sail

Group Sail is a coordinated training scenario with one submarine and either two guided missile destroyers or one guided missile cruiser, one guided missile destroyer and one fast frigate. The ships and their embarked helicopters conduct anti-submarine warfare localization training using AN/SQS-53, AN/SQS-56 and AN/AQS-13 or AN/AQS-22 dipping sonar. Submarine involved in these exercises also operate AN/BQQ-10 sonar periodically. Four tonal sonobuoys and two acoustic device countermeasures (MK-1, MK-2, MK-3, MK-4, noise acoustic emitter, and the AN/SLQ-25A NIXIE) may also be used per scenario. The number of passive sonobuoys deployed can vary. In addition, up to two MK-48 torpedoes could be fired per exercise.

Integrated Anti-Submarine Warfare Course

The Integrated Anti-Submarine Warfare Course (IAC) is a tailored course of instruction designed to improve Sea Combat Commander and Strike Group integrated anti-submarine warfare skill sets. Key components for this course of instruction include coordinated anti-submarine warfare training for the Sea Combat Commander or Anti-Submarine Warfare Commander and staff, key shipboard decision makers, and anti-submarine warfare watch teams. IAC consists of two phases, IAC Phase I and IAC Phase II. IAC Phase I is an approved Navy course of instruction consisting of five days of basic and intermediate level classroom training. IAC Phase II is intended to leverage the knowledge gained during IAC Phase I and build the basic anti-submarine warfare coordination and integration skills of the Strike Group anti-submarine warfare Team. IAC Phase II is a coordinated training scenario that typically involves three guided missile destroyers, one guided missile cruiser and one fast frigate, two to three embarked helicopters, one submarine, and one maritime patrol aircraft searching for, locating, and attacking one submarine.

The scenario consists of two 12-hour events that occur five times per year. While the ships are searching for the submarine, the submarine may practice simulated attacks against the ships. The ships and their embarked helicopters conduct anti-submarine warfare localization training using AN/SQS-53, AN/SQS-56, AN/AQS-13 or AN/AQS-22 dipping sonar. Submarines would also operate AN/BQQ-10 sonar periodically. About 36 tonal sonobuoys may also be used per event. Multiple acoustic sources may be active at one time. These events would occur within and seaward of the Virginia Capes, Cherry Point, and Jacksonville-Charleston Operating Areas or within and adjacent to the Gulf of Mexico Operating Area. During these exercises, some activities may occur in more than one Operating Area.

Submarine Command Course Operations

This scenario is conducted as training for submarine Executive and Commanding Officers, and involves two submarines conducting anti-submarine warfare training using AN/BQQ-10 sonar systems, as well as four acoustic device countermeasures (MK-1, MK-2, MK-3, MK-4, noise acoustic emitter, and the AN/SLQ-25A NIXIE) per scenario. In addition, up to 36 MK-48 torpedoes could be fired during the duration of an exercise.

Submarine Command Course Operations exercises occur two times per year, last from 3 to 5 days, and typically occur in the Jacksonville-Charleston and Northeast Operating Areas in deep ocean areas. Since targets may be employed, a support vessel may be required, which limits the western edge of the exercise boundary to within 148 km (80 nm) of a support facility.

Squadron Exercise and Gulf of Mexico Exercise

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

1.8.1.1.3 Strike Group Training

The Expeditionary Strike Group (ESG) and Carrier Strike Group (CSG) consist of multiple ships, aircraft and submarines operating as an integrated force. A typical Expeditionary Strike Group or Carrier Strike Group consists of up to six surface ships, one to five aircraft, and one submarine.

Composite Training Unit Exercise

Composite Training Unit Exercises (COMPTUEX) are designed to provide coordinated training to entire Expeditionary Strike Group and Carrier Strike Groups. An Expeditionary Strike Group COMPTUEX consists of a U.S. Navy Expeditionary Strike Group and U.S. Marine Corps units conducting integrated maritime and amphibious operations. Activities that employ active sonar during these exercises include anti-submarine warfare proficiency training, battle problem – area search and strait transit (a simulated choke point exercise), littoral anti-submarine warfare activities, coordinated anti-submarine warfare activities, and Improved Extended Echo Ranging (IEER) Systems training. Other activities that occur during these exercises include the insertion of amphibious forces onto a beach, movement of vehicles and troops over land, delivery of troops and equipment from ship to shore via helicopters and fixed-wing maritime patrol aircraft, the use of live-fire and blank munitions from ground-based troops and aircraft, and ship operations. In addition, Navy ships provide indirect Naval Surface Fire Support in support of the landing amphibious forces utilizing non-explosive ordnance.

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

Sonars employed in these exercises include AN/SQS-53, AN/SQS-56, AN/AQS-13 or AN/AQS-22 dipping sonar, and the AN/BQQ-10 sonar. Up to 218 tonal sonobuoys, 28 explosive source sonobuoys (AN/SSQ-110A), 5 receiver sonobuoys (AN/SSQ-101), and four acoustic device countermeasures (MK-1, MK-2, MK-

3, MK-4, noise acoustic emitter, and the AN/SLQ-25A NIXIE) are typically used per exercise. The number of passive sonobuoys deployed during these exercises can vary.

Each Composite Training Unit Exercises lasts about 21 days and four of these training exercises are conducted each year along the Atlantic Coast of the United States and one in the Gulf of Mexico. Along the Atlantic Coast, these exercises would occur within and seaward of the Virginia Capes, Cherry Point, and Jacksonville-Charleston Operating Areas. Within the Gulf of Mexico, these exercises would occur adjacent to the Gulf of Mexico Operating Area. Some activities that occur during these exercises might occur in more than one Operating Area.

Joint Task Force Exercise

Joint Task Force Exercises are also major range events that are the culminating exercises in Integrated Phase training for Carrier and Expeditionary Strike Groups. For Expeditionary Strike Groups, Joint Task Force Exercises incorporate Amphibious Ready Group Certification Exercises for amphibious ships and Special Operations Capable Certification for Marine Expeditionary Units. When schedules allow, these exercises may be conducted concurrently for a Carrier Strike Group and an Expeditionary Strike Group. These exercises normally last for 10 days (not including a 3-day force protection exercise that occurs in-port) and are the final at-sea exercise for the Carrier or Expeditionary Strike Groups before they are deployed. These exercises have generally occurred three to four times per year.

Joint Task Force Exercises are the final fleet exercises before deployment of Carrier and Expeditionary Strike Groups. These exercises would be scheduled after a Carrier Strike Group COMPTUEX to certify that a Strike Group is ready for deployment. Activities conducted during these exercises include littoral anti-submarine warfare activities, coordinated anti-submarine warfare activities, Improved Extended Echo Ranging (IEER) Systems training, and freeplay exercises. They typically include other Defense Department services or Allied forces.

Carrier Strike Group COMPTUEX and Joint Task Force Exercises often take place concurrently to produce exercises that are called Combined Carrier Strike Group COMPTUEX/JTFEX. Typically, four guided missile destroyers, two fast frigates, and three submarines participate in a Joint Task Force Exercises. Sonars employed in this scenario include the AN/SQS-53, AN/SQS-56, AN/AQS-13 or AN/AQS-22 dipping sonar, and the AN/BQQ-10 sonars. Up to 174 tonal sonobuoys (e.g., AN/SSQ-62), 28 explosive source sonobuoys (AN/SSQ-110A), five receiver sonobuoys (AN/SSQ-101), and 2 four acoustic device countermeasures (MK-1, MK-2, MK-3, MK-4, noise acoustic emitter, and the AN/SLQ-25A NIXIE) are typically used per exercise. The number of passive sonobuoys that are deployed during these exercises can vary.

These exercises generally last for 10 days and occur two times per year in shallow and deep water portions located within and seaward of the Virginia Capes, Cherry Point, and Jacksonville-Charleston Operating Areas.

1.8.1.1.4. Sustainment Training

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

1.8.1.1.5. Maintenance

The U.S. Navy plans to continue conducting about 510 maintenance training events each year. Specific training scenarios include the following:

Surface Ship Sonar Maintenance

This scenario consists of surface ships performing periodic maintenance to the AN/SQS-53 or AN/SQS-56 sonar while in port or at sea. This maintenance takes up to 4 hours. Surface ships would be operating their active sonar systems for maintenance while in shallow water near their homeport, located in either Norfolk, Virginia or Mayport, Florida. However, sonar maintenance could occur anywhere as the system's performance may warrant.

Submarine Sonar Maintenance

A submarine performs periodic maintenance on the AN/BQQ-10 and AN/BQS-15 sonar systems while in port or at sea. This maintenance takes from 45 minutes to one hour. Submarines would conduct maintenance to their sonar systems in shallow water near their homeport of either Groton, Connecticut; Norfolk, Virginia; or Kings Bay, Georgia. However, sonar maintenance could occur anywhere as the system8s performance may warrant.

1.8.1.2 Sonar Systems

During anti-submarine warfare and mine warfare training activities, the U.S. Navy uses tactical military sonars that were designed to (1) search for, detect, localize, and classify mine-like object or (2) obtain information concerning distant objects such as enemy vessels. The U.S. Navy typically employs two types of sonars, passive and active:

1. Passive sonars only listen to incoming sounds and, since they do not emit sound energy in the water, lack the potential to acoustically affect the environment.

2. Active sonars generate and emit acoustic energy specifically for the purpose of obtaining information concerning a distant object from the received and processed reflected sound energy. These sonars may produce high-frequency, mid-frequency, or low-frequency active signals.

The simplest active sonars emit omnidirectional pulses or "pings" and calculate the length of time the reflected echoes return from the target object to determine the distance between the sonar source and a target. More sophisticated active sonar emits an omnidirectional ping and then scans a steered receiving beam to calculate the direction and distance of a target. More advanced sonars transmit multiple preformed beams, listening to echoes from several directions simultaneously and providing efficient detection of both direction and range.

Because passive sonars do not introduce energy into the marine environment, we do not discuss them further in this consultation (readers interested in these sonar systems should refer to Appendix C of the U.S. Navy's Final Environmental Impact Statement for AFAST ; (Navy 2008a)). The active sources that would be used in training activities along the Atlantic Coast of the United States and in the Gulf of Mexico include:

Sonar Systems Associated with Surface Ships

A variety of surface ships participate in Navy training exercises, including guided missile cruisers, destroyers, guided missile destroyers, and frigates. Some ships (e.g., aircraft carriers) do not have any onboard active sonar systems, other than fathometers. Others, like guided missile cruisers, are equipped with active as well as passive sonars for submarine detection and tracking. The primary surface ship sonars considered are

1. The AN/SQS-53 which is a large, active-passive, bow-mounted sonar that has been operational since 1975. AN/SQS-53 is the U.S. Navy's most powerful surface ship sonar and is installed on Ticonderoga (22 units) and Arleigh Burke I/II/IIIa (51 units) class vessels in the U.S. Navy (Polmar 2001, D`Spain *et al.* 2006). This sonar transmits at a center frequency of 3.5 kHz at source levels of 235 dB_{RMS} re: 1 μPa at 1 meter. The sonar has pulse durations between 1 and 2 seconds, with about 24-second intervals between pulses. AN/SQS-53 operates at depths of about 7 meters.

The AN/SQS-53 is a computer-controlled, hull-mounted surface-ship sonar that has both active and passive operating capabilities, providing precise information for anti-submarine warfare weapons control and guidance. The system is designed to perform direct-path anti-submarine warfare search, detection, localization, and tracking from a hull-mounted transducer array. The

AN/SQS-53 sonar is installed on Arleigh Burke Class guided missile destroyers and Ticonderoga Class guided missile cruisers. The AN/SQS-53 Kingfisher is a modification that provides a surface ship with the ability to detect mine-like objects.

2. The AN/SQS-56 system is a lighter active-passive bow-mounted sonar that has been operational since 1977. AN/SQS-56 is installed on FFG-7 (33 units) class guided missile frigates in the U.S. Navy (Polmar 2001; D'Spain et al 2006c). This sonar transmits at a center frequency of 7.5 kHz and a source level of 225 dB_{RMS} re: 1 μPa at 1 meter source level. This sonar also has pulse durations between 1 and 2 seconds, with about 24-second intervals between pulses. AN/SQS-56 operates at depths of about 6 meters.

Sonar Systems Associated with Submarines

Tactical military submarines (i.e. 29 attack submarines as of 2008) equipped with hull-mounted mid-frequency sonar use active sonar to detect and target enemy submarines and surface ships. The predominant active sonar system mounted on submarines is AN/BQQ-10 sonar that is used to detect and target enemy submarines and surface ships. Two other systems — AN/BQQ-5 and AN/BSY-1/2 — have operational parameters that would affect marine mammals in ways that are similar to the AN/BQQ-10. In addition, Seawolf Class attack submarines, Virginia Class attack submarines, Los Angeles Class attack submarines, and Ohio Class nuclear guided missile submarines also have the AN/BQS-15 sonar system, which uses high-frequency for under-ice navigation and mine-hunting.

1. AN/BQQ-10 (also known as Advanced Rapid Commercial-Off-the-Shelf Insertion) is a four-phase program for transforming existing submarine sonar systems (i.e., AN/BQQ -5) from legacy systems to more capable and flexible active and passive systems with enhanced processing using commercial-off-the-shelf components. The system is characterized as mid-frequency active sonar, although the exact frequency range is classified. The AN/BQQ-10 is installed on Seawolf Class SSNs, Virginia Class SSNs, Los Angeles Class SSNs, and Ohio Class SSBN/nuclear guided missile submarines (SSGNs). The BQQ-10 systems installed on Ohio Class SSBNs do not have an active sonar capability.

2. AN/BQQ-5 – a bow- and hull-mounted passive and active search and attack sonar system. The system includes the TB-16 and TB-23 or TB-29 towed arrays and Combat Control System MK 2. This sonar system is characterized as mid-frequency active sonar, although the exact frequency range is classified. The AN/BQQ-5 sonar system is installed on Los Angeles Class nuclear attack submarines (SSNs) and Ohio Class ballistic missile nuclear submarines (SSBNs), although the AN/BQQ-5 systems installed on Ohio Class SSBNs do not have an active sonar capability. The AN/BQQ-5 system is being phased out on all submarines in favor of the AN/BQQ-10 sonar.

Sonar Systems Associated with Aircraft

Aircraft sonar systems that typically operate during Navy training exercises include sonobuoys and dipping sonar. Current dipping sonar systems used by the Navy are either AN/SQS-22 or AN/AQS -13. AN/AQS -13 is an older and less powerful dipping sonar system (maximum source level 215 dB re µPa-s^2 at 1m) than the AN/AQS -22 (maximum source level 217 dB re µPa-s^2 at 1m). In its modeling, the Navy assumed that all dipping sonar were AN/AQS -22. P-3 aircraft may deploy sonobuoys while helicopters may deploy sonobuoys or dipping sonars (the latter are used by carrier-based helicopters). Sonobuoys are expendable devices used by aircraft for the detection of underwater acoustic energy and for conducting vertical water column temperature measurements. Dipping sonar is an active or passive sonar device lowered on cable by helicopters to detect or maintain contact with underwater targets. In addition, the U.S. Navy employs tonal sonobuoys (DICASS, AN/SSQ-62) and the Improved Extended Echo Ranging (IEER) System discussed earlier.

1. The AN/SSQ-62C Directional Command Activated Sonobuoy System (DICASS) sonar system is part of a sonobuoy that operates under direct command of fixed-wing aircraft or helicopters. The system can determine the range and bearing of the target relative to the sonobuoys position and can deploy to various depths within the water column. After it enters the water, the sonobuoy transmits sonar pulses (continuous waveform or linear frequency modulation) upon command from the aircraft. The echoes from the active sonar signal are processed in the buoy and transmitted to the receiving station onboard the launching aircraft.

2. AN/SSQ-110A Explosive Source Sonobuoy – a commandable, air-dropped, high source level explosive sonobuoy. The AN/SSQ-110A explosive source sonobuoy is composed of two sections, an active (explosive) section and a passive section. The upper section is called the "control buoy" and is similar to the upper electronics package of the AN/SSQ-62 DICASS sonobuoy. The lower section consists of two signal underwater sound explosive payloads of Class A explosive weighing 1.9 kg (4.2 lbs) each. The arming and firing mechanism is hydrostatically armed and detonated. Once in the water, the signal underwater sound charges explode, creating a loud acoustic signal. The echoes from the explosive charge are then analyzed on the aircraft to determine a submarine's position. The AN/SSQ-110A explosive source sonobuoy is deployed by maritime patrol aircraft.

In their request for a 2011 Letter of Authorization, the U.S. Navy proposed to maintain the number of AN/SSQ-110A (IEER explosive) sonobuoys it would employ at 1,725 while eliminating the use of the high-frequency active sonar, variable depth mine detection and classification system (AN/SQQ-32).

3. AN/SSQ-125 Advanced Extended Echo Ranging (AEER) Sonobuoy - a third generation of multi-static active acoustic search systems to be developed under the Extended Echo Ranging family of

the systems and is being developed as the replacement for the AN/SSQ-110A. The AN/SSQ-125 sonobuoy is composed of two sections, the control section and the active source section. The control section is similar to the upper electronics package of the AN/SSQ-62 DICASS sonobuoy. The lower section consists of the active sonar source. The echoes from pings of the sonar are then analyzed on the aircraft to determine a submarine's position. The AN/SSQ-125 sonobuoy will be deployed by maritime patrol aircraft.

In their request for a 2011 Letter of Authorization, the U.S. Navy proposed to maintain the number of AN/SSQ-125 (AEER sonar) sonobuoys it would employ at 1,550 while eliminating the use of the high-frequency active sonar, variable depth mine detection and classification system (AN/SQQ-32).

Torpedoes

Torpedoes (primarily MK-46 and MK-48) are the primary anti-submarine warfare weapon used by surface ships, aircraft, and submarines. The guidance systems of these weapons can be autonomous or electronically controlled from the launching platform through an attached wire. The autonomous guidance systems are acoustically based. They operate either passively, exploiting the emitted sound energy by the target, or actively ensonifying the target and using the received echoes for guidance.

In addition to these torpedoes, the U.S. Navy employs Acoustic Device Countermeasures in several of their training exercises. These countermeasures (which include MK-1, MK-2, MK-3, MK-4, noise acoustic emitter, and the AN/SLQ-25A NIXIE) act as decoys by making sounds that simulate submarines to avert localization or torpedo attacks. The U.S. Navy proposed to maintain the 2010 increase in the number of sonar hours associated with the AN/SLQ-25 NIXIE system and operate up to 2,500 hours while maintaining the zero hours use of the AN/SQQ-32 system.

1.8.1.3 Mine Warfare Sonar Systems

The U.S. Navy uses a variety of different sonar systems during mine warfare training exercises. These sonar systems are typically high-frequency sonars (i.e., greater than 10 kHz) that detect, locate, and characterize moored and bottom mines and can be deployed by helicopters, unmanned underwater vehicles, surf zone crawlers, or surface ships. The majority of mine warfare systems are deployed by helicopters and typically operate at high (greater than 200 kHz) frequencies. The types of tactical acoustic sources used during mine warfare sonar training activities include the following:

SURFACE SHIP SONARS**.** Guided missile destroyers, fast frigates, and guided missile cruisers can use their hull-mounted sonars (AN/SQS-53 and AN/SQS-56) in the object detection (Kingfisher) mode. These ships, as well as mine hunters, may utilize over-the-side unmanned underwater vehicle systems containing sonar sensor packages to detect and classify mine shapes. Navy minesweepers use the AN/SQQ-32, a variable depth mine detection and classification high-frequency active sonar system, although the U.S. Navy does not propose to employ this system as part of the active sonar training it plans to conduct along the Atlantic coast over the next twelve months. In addition, mine hunters are equipped with underwater acoustic communication systems.

SUBMARINE SONARS**.** Submarines can use a sail-mounted sonar, AN/BQS-15, to detect mines and objects. In addition, they employ the AN/BLQ-11 Long Term Mine Reconnaissance System which is an unmanned underwater vehicle that, when in operation, can be launched and recovered through the torpedo tubes by all classes of submarines. It can be equipped with mid-frequency active sonar to detect mines and is intended to extend a submarine's reach for mine reconnaissance missions.

In addition, the U.S. Navy employs active sonar systems from aircraft as part of its mine warfare scenarios. Two systems in particular – AN/AQS-14, which is an active-controlled, helicopter-towed mine-hunting active sonar and AN/AQS-24 which is an upgraded version of AN/AQS-14 – operate above 200 kHz.

1.8.1.4 Location of Training Activities

The U.S. Navy's Final Environmental Impact Statement for Atlantic Fleet Active Sonar Training (AFAST) identified specific areas where different training activities would occur. Some of those areas have been included in the narratives for specific training scenarios; the other locations are as follows:

Anti-submarine Warfare Training Areas

Anti-submarine warfare activities for all platforms could occur within and adjacent to the existing East Coast operating area, however, most anti-submarine warfare training involving submarines or submarine targets would occur in waters greater than 183 m (600 ft) deep due to safety concerns about running aground at shallower depths.

Helicopter Anti-Submarine Warfare Unit-Level Training Areas

Helicopter anti-submarine warfare Unit-Level Training is the only anti-submarine warfare activity that could occur within 22 km (12 nm) of shore. This activity would be conducted by helicopters embarked on a surface ship in the waters of the East Coast Operating Areas. Helicopter anti-submarine warfare Unit-Level Training events are also conducted by helicopters deployed from shore-based Jacksonville, Florida, units. These helicopter units use established sonar dipping areas off of Mayport, Florida, which are located in territorial waters and within the southeast Atlantic Ocean, off the coast of Jacksonville, Florida.

Torpedo Exercise Areas

Torpedo Exercises could occur anywhere within and adjacent to East Coast and Gulf of Mexico Operating Areas. The exception is in the Northeast Operating Area where the North Atlantic right whale feeding area exists. Torpedo Exercise areas that meet current operational requirements for proximity to torpedo and target recovery support facilities were established during earlier Endangered Species Act Section 7 consultations with the National Marine Fisheries Service. As a result of these consultations, Torpedo Exercise activities in the northeast are limited to these established areas.

Torpedo firing activities would occur within the Virginia Capes and Gulf of Mexico Operating Areas, and within and seaward of the Northeast Operating Area. Due to operational requirements for torpedo recovery operations, support facilities must be located within 148 km (80 nm) of the torpedo exercise area.

Mine Warfare Training Areas

Mine Warfare Training could occur in territorial or non-territorial waters. Independent and Coordinated Mine Warfare Unit-Level Training activities would be conducted within and adjacent to the Pensacola and Panama City Operating Areas in the northern Gulf of Mexico and off the east coast of Texas in the Corpus Christi Operating Area. Squadron or Gulf of Mexico Exercises would be conducted in both deep and shallow water training areas.

Object Detection/Navigational Training Areas

Surface Ship training would be conducted primarily in the shallow water port entrance and exit lanes for Norfolk, Virginia and Mayport, Florida. The transit lane servicing Mayport, Florida, crosses through the southeast where North Atlantic right whales spent part of the year with calves. Submarine training would occur primarily in the established submarine transit lanes entering/exiting Groton, Connecticut; Norfolk, Virginia; and Kings Bay, Georgia. The transit lane servicing Kings Bay, Georgia, crosses through the southeast, where North Atlantic right whales spent part of the year with calves.

Surface Ship Sonar Maintenance Areas

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

Submarine Sonar Maintenance Areas

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

1.8.1.5. Scope of the MMPA Letter of Authorization

The Letter of Authorization the Permits Division issued authorizes the "taking" of marine mammals by the Navy only if it occurs within the AFAST Study Area, which extends east from the Atlantic Coast of the U.S. to 45 degrees W longitude and south from the Atlantic and Gulf of Mexico Coasts to approximately 23 degrees N latitude, excluding the Bahamas. The "taking" of marine mammals (as that term is defined for the purposes of the Marine Mammal Protection Act) by the Navy is only authorized if it occurs incidental to the use of the following mid-frequency active sonar (MFAS) sources, high frequency active sonar (HFAS) sources, or explosive sonobuoys for U.S. Navy an-ti-submarine warfare (ASW), mine warfare (MIW) training, maintenance, or research, development, testing, and evaluation (RDT&E) in the amounts indicated as follows (± 10 percent):

1. AN/SQS-53 (hull-mounted sonar) – 3214 hours

2. AN/SQS-56 (hull-mounted sonar) – 1684 hours

3. AN/SQS-56 or 53 (hull mounted sonar in object detection mode) – 216 hours

4. AN/BQQ-10 or 5 (submarine sonar) – 9976 pings (an average of 1 ping per two hours during training events, 60 pings per hour for maintenance)

5. AN/AQS-22 or 13 (helicopter dipping sonar) –2952 dips – 10 pings per five-minute dip

6. SSQ-62 (Directional Command Activated Sonobuoy System (DICASS) sonobuoys) – 5,853 sonobuoys

7. MK-48 (heavyweight torpedoes) – 32 torpedoes

8. MK-46 or 54 (lightweight torpedoes) – 24 torpedoes

9. AN/SSQ-110A (IEER explosive sonobuoy) and AN/SSQ-125 (AEER sonar sonobuoy) – 1725 and 1550 buoys, respectively

10. AN/SLQ-25 (NIXIE – towed countermeasure) – 2,500 hours

11.AN/BQS-15 (submarine navigation) – 450 hours

12. MK-1 or 2 or 3 or 4 (Submarine-fired Acoustic Device Countermeasure (ADC)) **-** 225 ADCs

13. Noise Acoustic Emitters (NAE – Sub-fired countermeasure) **-** 127 NAEs

Notwithstanding the forms of takings contemplated in the regulations and that would be authorized by the proposed 2011 LOA, the regulations do not authorize persons connected with the activities the regulations cover to:

1. "Take" any marine mammals that are not specifically identified in the regulations;

2. "Take" any of the marine mammals identified in the regulations other than by incidental take;

3. "Take" a marine mammal identified in the regulations if such taking results in more than a negligible impact on the species or stocks of such marine mammal; or

4. Violate, or fail to comply with, the terms, conditions, and requirements of the regulations or LOA issued under the regulations.

1.8.1.6. The U.S. Navy's Mitigation Measures

As required to satisfy the requirements of the Marine Mammal Protection Act of 1972, as amended, the U.S. Navy's has developed and implements measures that are designed to allow their training activities to have the least practicable adverse impact on marine mammal species or stocks (which includes considerations of personnel safety, practicality of implementation, and impact on the effectiveness of the "military readiness activity"). Those measures are summarized in this section of this Opinion; for a complete description of all of the measures applicable to its training activities, readers should refer to the U.S. Navy's request for a letter of authorization and the Permit Division's MMPA regulations:

The U.S. Navy does not currently conduct active sonar training in feeding or calving habitat for the North Atlantic right whale with the exception of object detection and navigation off shore Mayport, Florida and Kings Bay, Georgia; helicopter anti-submarine warfare training activities offshore Mayport, Florida; and torpedo exercises in the northeast during the months of August and September. The U.S. Navy does not plan to conduct active sonar activities within the Stellwagen Bank, Monitor, Gray's Reef, Flower Garden Banks, and Florida Keys National Marine Sanctuaries and will avoid these sanctuaries by observing a 5 km (2.7 nautical mile or nm) buffer. In addition, the U.S. Navy uses the following measures to mitigate the effects of its training activities on marine mammals:

1.0 *Measures Applicable to Hull-Mounted Surface and Submarine Active Sonar*.

1.1 Personnel Training

1.1.1 All lookouts onboard platforms involved in ASW training events will review the NMFS approved MSAT material prior to MFA sonar use.

1.1.2 All Commanding Officers, Executive Officers, and officers standing watch on the Bridge will have reviewed the MSAT material prior to a training event employing the use of MFA sonar.

1.1.3 Navy lookouts will undertake extensive training in order to qualify as a watchstander in accordance with the Lookout Training Handbook (NAVEDTRA 12968-D).

1.1.4 Lookout training will include on-the-job instruction under the supervision of a qualified, experienced watchstander. Following successful completion of this supervised training period, Lookouts will complete the Personal Qualification Standard program, certifying that they have demonstrated the necessary skills (such as detection and reporting of partially submerged objects). This does not preclude personnel being trained as lookouts from being counted as those listed in previous measures so long as supervisors monitor their progress and performance.

1.1.5 Lookouts will be trained in the most effective means to ensure quick and effective communication within the command structure in order to facilitate implementation of protective measures if marine species are spotted.

1.2 Lookout and Watchstander Responsibilties

1.2.1 On the bridge of surface ships, there will always be at least three personnel on watch whose duties include observing the water surface around the vessel.

1.2.2 In addition to the three personnel on watch noted previously, all surface ships participating in ASW exercises will have at least two additional personnel on watch as lookouts at all times during the exercise.

1.2.3 Personnel on lookout and officers on watch on the bridge will have at least one set of binoculars available for each person to aid in the detection of marine mammals.

1.2.4 On surface vessels equipped with MFA sonar, pedestal mounted "Big Eye" (20x110) binoculars will be present and in good working order to assist in the detection of marine mammals in the vicinity of the vessel.

1.2.5 Personnel on lookout will employ visual search procedures employing a scanning methodology in accordance with the Lookout Training Handbook (NAVEDTRA 12968-D).

1.2.6 After sunset and prior to sunrise, lookouts will employ Night Lookouts Techniques in accordance with the Lookout Training Handbook.

1.2.7 At night, lookouts would not sweep the horizon with their eyes, because eyes do not see well when they are moving. Lookouts would scan the horizon in a series of movements that would allow their eyes to come to periodic rests as they scan the sector. When visually searching at night, they would look a little to one side and out of the corners of their eyes, paying attention to the things on the outer edges of their field of vision. Lookouts will also have night vision devices available for use.

1.2.8 Personnel on lookout will be responsible for reporting all objects or anomalies sighted in the water (regardless of the distance from the vessel) to the Officer of the Deck, since any object or disturbance (e.g., trash, periscope, surface disturbance, discoloration) in the water may be indicative of a threat to the vessel and its crew or indicative of a marine species that may need to be avoided as warranted.

1.3 Operating procedures

1.3.1 Commanding Officers will make use of marine species detection cues and information to limit interaction with marine species to the maximum extent possible consistent with safety of the ship.

1.3.2 All personnel engaged in passive acoustic sonar operation (including aircraft, surface ships, or submarines) will monitor for marine mammal vocalizations and report the detection of any marine mammal to the appropriate watch station for dissemination and appropriate action.

1.3.3 During MFA sonar operations, personnel will utilize all available sensor and optical systems (such as night vision goggles) to aid in the detection of marine mammals.

1.3.4 Navy aircraft participating in exercises at sea will conduct and maintain, when operationally feasible and safe, surveillance for marine species of concern as long as it does not violate safety constraints or interfere with the accomplishment of primary operational duties.

1.3.5 Aircraft with deployed sonobuoys will use only the passive capability of sonobuoys when marine mammals are detected within 200 yards of the sonobuoy.

1.3.6 Marine mammal detections will be immediately reported to assigned Aircraft Control Unit (if participating) for further dissemination to ships in the vicinity of the marine species as appropriate where it is reasonable to conclude that the course of the ship will likely result in a closing of the distance to the detected marine mammal.

1.3.7 Safety Zones—When marine mammals are detected by any means (aircraft, shipboard lookout, or acoustically), the Navy will ensure that MFA transmission levels are limited to at least 6 decibels (dB) below normal operating levels if any detected animals are within 1,000 yards of the sonar dome (the bow)

(i) Ships and submarines will continue to limit maximum MFA transmission levels by this 6-dB factor until the marine mammal has been seen to leave the area, has not been detected for 30 minutes, or the vessel has transited more than 2,000 yards beyond the location of the last detection.

(ii) The Navy will ensure that MFA sonar transmissions will be limited to at least 10 dB below the equipment's normal operating level if any detected animals are within 500 yards of the sonar dome. Ships and submarines will continue to limit maximum ping levels by this 10-dB factor until the marine mammal has been seen to leave the area, has not been detected for 30 minutes, or the vessel has transited more than 2,000 yards beyond the location of the last detection.

(iii) The Navy will ensure that MFA sonar transmissions will cease if any detected animals are within 200 yards of the sonar dome. MFA sonar will not resume until the animal has been seen to leave the area, has not been detected for 30 minutes, or the vessel has transited more than 2,000 yards beyond the location of the last detection.

(iv) Special conditions applicable for dolphins and porpoises only: If, after conducting an initial maneuver to avoid close quarters with dolphins or porpoises, the Officer of the Deck concludes that dolphins or porpoises are deliberately closing to ride the vessel's bow wave, no further mitigation actions are necessary while the dolphins or porpoises continue to exhibit bow wave riding behavior.

(v) If the need for MFA sonar power-down should arise as detailed in “Safety Zones” above, the ship or submarine shall follow the requirements as though they were operating MFA sonar at 235 dB—the normal operating level (i.e., the first power-down will be to 229 dB, regardless of at what level above 235 dB the MFA sonar was being operated).

1.3.8 Prior to start up or restart of MFA sonar, operators will check that the Safety Zone radius around the sound source is clear of marine mammals.

1.3.9 MFA sonar levels (generally)—the ship or submarine will operate MFA sonar at the lowest practicable level, not to exceed 235 dB, except as required to meet tactical training objectives.

1.3.10 If the need for power-down should arise, as detailed in ―Safety Zones (above), Navy staff would follow the requirements as though they were operating at 235 dB - the normal operating level (i.e., the first power-down would be to 229 dB, regardless of the level above 235 db the sonar was being operated).

1.3.11 Prior to start up or restart of active sonar, operators would check that the safety zone radius around the sound source is clear of marine mammals.

1.3.12 Sonar levels (generally) – The Navy would operate sonar at the lowest practicable level, not to exceed 235 dB, except as required to meet tactical training objectives.

1.3.13 Helicopters would observe/survey the vicinity of an ASW exercise for 10 minutes before the first deployment of active (dipping) sonar in the water.

1.3.14 Helicopters would not dip their sonar within 183 m (200 yd) of a marine mammal and would cease pinging if a marine mammal closes within 183 m (200 yd) after pinging has begun.

1.3.15 Submarine sonar operators would review detection indicators of close-aboard marine mammals prior to the commencement of ASW operations involving active mid-frequency sonar.

2.0 *Mitigation measures associated with events using IEER/AEER Sonobuoys*

a. Pattern Deployment:

- Crews will conduct visual reconnaissance of the drop area prior to laying their intended sonobuoy pattern. This search should be conducted below 1500 feet (ft) at a slow speed when operationally feasible and weather conditions permit. In dual aircraft operations, crews may conduct coordinated area clearances.

- Crews shall conduct a minimum of 30 minutes of visual and aural monitoring of the search area prior to commanding the first post (source/receiver sonobuoy pair) detonation (AN/SSQ_110 only) or activated (AN/SSQ-125). This 30 minute observation period may include pattern deployment time.

- For any part of the briefed pattern where a post will be deployed within 1000 yards (yds) of observed marine mammal activity, crews will deploy the receiver ONLY and monitor while conducting a visual search. When marine mammals are no longer detected within 1000 yds of the intended post position, crews will collocate the AN/SSQ-110A sonobuoy (source) with the receiver.

- When operationally feasible, crews will conduct continuous visual and aural monitoring of marine mammal activity, including monitoring of their aircraft sensors from first sensor placement to checking off-station and out of RF range of the sensors.

b. Pattern Employment:

(i) Aural Detection:

• Aural detection of marine mammals cues the aircrew to increase the diligence of their visual surveillance.

• If, following aural detection, no marine mammals are visually detected, then the crew may continue multi-static active search.

(ii) Visual Detection:

• If marine mammals are visually detected within 1000 yds of the AN/SSQ-110A sonobuoy intended for use, then that payload shall not be detonated (AN/SSQ_110 only) or activated (AN/SSQ-125). Aircrews may utilize this post once the marine mammals have not been re-sighted for 30 minutes or are observed to have moved outside the 1000 yd safety zone.

• Aircrews may shift their multi-static active search to another post, where marine mammals are outside the 1000 yd safety zone.

c. AN/SSQ-110A Scuttling Sonobuoys:

(i) Aircrews shall make every attempt to manually detonate the unexploded charges at each post in the pattern prior to departing the operations area by using the "Payload 1 Release" command followed by the "Payload 2 Release" command (applies to SSQ-110 sonobuoys only; SSQ-125 sonobuoys do not contain an explosive charge). Aircrews shall refrain from using the "Scuttle" command when two payloads remain at a given post. Aircrews will ensure a 1000 yd safety zone, visually clear of marine mammals, is maintained around each post as is done during active search operations.

(ii) Aircrews shall only leave posts with unexploded charges in the event of a sonobuoy malfunction, an aircraft system malfunction, or when an aircraft must immediately depart the area due to issues such as fuel constraints, inclement weather, and in-flight emergencies. In these cases, the sonobuoy will self-scuttle using the secondary method or tertiary method.

Aircrews ensure all payloads are accounted for. Sonobuoys that cannot be scuttled shall be reported as unexploded ordnance via voice communications while airborne and, upon landing, via Naval message.

(iii) Mammal monitoring shall continue until out of their aircraft sensor range.

3.0. Special Conditions Applicable to Bow-riding Dolphins

If, after conducting an initial maneuver to avoid close quarters with dolphins, the ship concludes that dolphins are deliberately closing in on the ship to ride the vessel‘s bow wave, no further mitigation actions would be necessary because dolphins are out of the main transmission axis of the active sonar while in the shallow-wave area of the vessel bow.

4.0. Planning Awareness Areas

The Navy has designated several Planning Awareness Areas (PAAs) based on areas of high productivity that have been correlated with high concentrations of marine mammals (such as persistent oceanographic features like upwellings associated with the Gulf Stream front where it is deflected off the east coast near the Outer Banks), and areas of steep bathymetric contours that are frequented by deep diving marine mammals such as beaked whales and sperm whales. In developing the PAAs, U.S. Fleet Forces (USFF) was able to consider these factors because of geographic flexibility in conducting ASW training. USFF is not tied to a specific range support structure for the majority of the training for AFAST. Additionally, the topography and bathymetry along the East Coast and in the Gulf of Mexico is unique in that there is a wide continental shelf leading to the shelf break affording a wider range of training opportunities.

4.1. The Navy shall avoid planning major exercises in the specified PAAs where feasible. Should national security require the conduct of more than four major exercises (Composite Training Unit Exercise [COMPTUEX], Joint Task Force Exercise [JTFEX], Southeastern ASW Integrated Training Initiative [SEASWITI], or similar scale event) in these areas (meaning all or a portion of the exercise) per year the Navy shall provide NMFS with prior notification and include the information in any associated after-action or monitoring reports.

4.2. To the extent operationally feasible, the Navy plans to conduct no more than one of the four above-mentioned major exercises (COMPTUEX, JTFEX, SEASWITI, or similar scale event) per year in the Gulf of Mexico. Based on operational requirements, the exercise area for this one exercise may include the De Soto Canyon. If national security needs require more than one major exercise to be conducted in the PAAs which includes portions of the DeSoto Canyon, the Navy would provide NMFS with prior notification and include the information in any associated after-action or monitoring reports.

4.3. The PAAs will be included in the Navy's Protective Measures Assessment Protocol (PMAP) (implemented by the Navy for use in the protection of the marine environment) for unit level situational awareness (i.e., exercises other than COMPTUEX, JTFEX, SEASWITI). The goal of PMAP is to raise awareness in the fleet and ensure common sense and informed oversight are injected into planning processes for testing and training evolutions.

4.4. Helicopter Dipping Sonar in southeast habitat identified for North Atlantic right whale calving

4.4.1. Helicopter Dipping Sonar is one of the two activity types that has been identified as planned to occur in the southern North Atlantic right whale calving areas. Historically, only maintenance of helicopter dipping sonars occurs within a portion of the North Atlantic right whale calving areas. Tactical training with helicopter dipping sonar does not typically occur in the North Atlantic right whale calving areas at any time of the year. The calving areas are used on occasion for post maintenance operational checks and equipment testing due to its proximity to shore. Unless otherwise dictated by national security needs, the Navy will minimize helicopter dipping sonar maintenance within the southeast North Atlantic right whale calving habitat from November 15 to April 15.

4.5. Object Detection Exercises in North Atlantic right whale calving areas

4.5.1. Object detection training requirements are another type of activity that have been identified as planned to occur in the southern North Atlantic right whale calving areas. The Navy recognizes the significance of the North Atlantic right whale calving area and has explored ways of effecting the least practicable impact (which includes a consideration of practicality of implementation and impacts to training fidelity) to right whales. Navy units will incorporate data from the Early Warning System (EWS) into exercise pre-planning efforts. USFF contributes more than $150,000 annually for aerial surveys that support the EWS, a communication network that assists afloat commands to avoid interactions with right whales. Fleet Area Control and Surveillance Facility, Jacksonville (FACSFAC JAX) houses the Whale Fusion Center, which disseminates the latest right whale sighting information to Navy ships, submarines, and aircraft. Through the Fusion Center, FACSFAC JAX coordinates ship and aircraft movement into the right whale calving area and the surrounding operating areas based on season, water temperature, weather conditions, and frequency of whale sightings and provides right whale reports to ships, submarines and aircraft, including coast guard vessels and civilian shipping. The Navy proposes to:

4.5.2. Reduce the time spent conducting object detection exercises in the North Atlantic right whale calving areas.

4.5.3. Prior to conducting surface ship object detection exercises in the southeast North Atlantic right whale calving areas during the time of November 15 to April 15, ships will contact FACSFAC JAX to obtain the latest right whale sighting information. FACSFAC JAX will advise ships of all reported whale sightings in the vicinity of the calving areas and Associated Area of Concern. To the extent operationally feasible, ships will avoid conducting training in the vicinity of recently sighted right whales. Ships will maneuver to maintain at least 457 m (500 yd) separation from any observed whale, consistent with the safety of the ship.

5.0. Mitigation Measures Related To Vessel Transit and North Atlantic Right Whales

In 1999, a Mandatory Ship Reporting System was implemented by the U.S. Coast Guard, which requires vessels larger than 300 gross registered tons (Department of the Navy ships are exempt) to report their location, course, speed, and destination upon entering the nursery and feeding areas of the right whale. At the same time, ships receive information on locations of right whale sightings, in order to avoid collisions with the animals. In the southeastern United States, the reporting system is from November 15 through April 15 of each year; the geographical boundaries include coastal waters within roughly 46 kilometers (25 nautical miles of shore along a 167 km (90 nm) stretch of the Atlantic coast in Florida and Georgia. In the northeastern United States, the reporting system is year-round and the geographical boundaries include the waters of Cape Cod Bay, Massachusetts Bay, and the Great South Channel east and southeast of Massachusetts; it includes all of Stellwagen Bank National Marine Sanctuary. A portion of the Boston OPAREA falls within these boundaries. Specific naval mitigation measures for each region of the AFAST Study Area are discussed in the following subsections.

5.1. Mid-Atlantic, Offshore of the Eastern United States

For purposes of these measures, the mid-Atlantic is defined broadly to include ports south and east of Block Island Sound southward to South Carolina. The procedure described below would be established as mitigation measures for Navy vessel transits during Atlantic right whale migratory seasons near ports located off the western North Atlantic, offshore of the eastern United States. The mitigation measures would apply to all Navy vessel transits, including those vessels that would transit to and from East Coast ports and OPAREAs. Seasonal migration of right whales is generally described by NMFS as occurring from October 15th through April 30th, when right whales migrate between feeding grounds farther north and calving grounds farther south. The Navy mitigation measures have been established in accordance with rolling dates identified by NMFS consistent with these seasonal patterns. NMFS has identified ports located in the western Atlantic Ocean, offshore of the southeastern United States, where vessel transit during right whale migration is of highest concern for potential ship strike. The ports include the Hampton Roads entrance to the Chesapeake Bay, which includes the concentration of Atlantic Fleet vessels in Norfolk, Virginia. Navy vessels are required to use extreme caution and operate at a slow, safe speed consistent with mission and safety during the months (indicated in Table 5-1 of the Final EIS for Atlantic Fleet Active Sonar Training) and within a 37 kilometer (20 nautical mile) arc (except as noted) of the specified reference points.

During the indicated months, Navy vessels would practice increased vigilance with respect to avoidance of vessel-whale interactions along the mid-Atlantic coast, including transits to and from any mid-Atlantic ports not specifically identified above. All surface(d) units transiting within 56 km (30 nm) of the coast in the mid-Atlantic would ensure at least two watchstanders are posted, including at least one lookout that has completed required MSAT training. Furthermore, Navy vessels would not knowingly approach any whale head on and would maneuver to keep at least 457 m (500 yd) away from any observed whale, consistent with vessel safety.

5.2. Southeast Atlantic, Offshore of the Eastern United States

For purposes of these measures, the southeast encompasses sea space from Charleston, South Carolina, southward to Sebastian Inlet, Florida, and from the coast seaward to 148 km (80 nm) from shore. The mitigation measures described in this section were developed specifically to protect the North Atlantic right whale during its calving season (Typically from November 15 through April 15). During this period, North Atlantic right whales give birth and nurse their calves off the coast of Georgia and Florida.

This habitat is the area from 31-15N to 30-15N extending from the coast out to 28 km (15 nm), and the area from 28-00N to 30-15N from the coast out to 9 km (5 nm). All mitigation measures that apply to the calving areas also apply to an associated area of concern which extends 9 km (5 nm) seaward of the designated boundaries. Prior to transiting or training in an area of concern, ships will contact Fleet Area Control and Surveillance Facility, Jacksonville, to obtain latest whale sighting and other information needed to make informed decisions regarding safe speed and path of intended movement. Subs shall contact Commander, Submarine Group Ten for similar information. Specific mitigation measures related to activities occurring within an area of concern include the following:

5.2.1. When transiting within an area of concern, vessels will exercise extreme caution and proceed at a slow safe speed. The speed will be the slowest safe speed that is consistent with mission, training and operations.

5.2.2. Speed reductions (adjustments) are required when a whale is sighted by a vessel or when the vessel is within 9 km (5 nm) of a reported new sighting less than 12 hours old.

5.2.3. Additionally, circumstances could arise where, in order to avoid North Atlantic right whale(s), speed reductions could mean a vessel must reduce speed to a minimum at which it can safely keep on course or vessels could come to an all stop.

5.2.4. Vessels will avoid head-on approach to North Atlantic right whale(s) and will maneuver to maintain at least 457 m (500 yd) of separation from any observed whale if deemed safe to do so. These requirements do not apply if a vessel‘s safety is threatened, such as when change of course would create an imminent and serious threat to person, vessel, or aircraft, and to the extent vessels are restricted in the ability to maneuver.

5.2.5. Ships shall not transit through an area of concern in a North-South direction.

5.2.6. Ship, surfaced subs, and aircraft will report any whale sightings to Fleet Area Control and Surveillance Facility, Jacksonville, by most convenient and fast means. Sighting report will include the time, latitude/longitude, direction of movement and number and description of whale (i.e., adult/calf).

5.3. Northeast Atlantic, Offshore of the Eastern United States

The protective measures described in this section apply to aircraft operating in the Boston OPAREA (Warning Areas W-102, W-103, and W-104), as well as ships operating within the entire Atlantic Fleet area of responsibility (AOR), except those areas off the southeastern U.S. already covered in previous discussion.

Prior to transiting the Great South Channel or Cape Cod Bay feeding areas, ships will obtain the latest right whale sightings and other information needed to make informed decisions regarding safe speed. The Great South Channel feeding area is defined by the following coordinates: 41°40N, 69° 45W; 41°00N, 69°05W; 41°38N, 68°13W; 42°10N, 68°31W. The Cape Cod Bay critical habitat is defined by the following coordinates: 42°04.8N, 70°10W; 42° 12N, 70°15W; 42°12N, 70° 30W; 41° 46.8N, 70°30W. Ships, surfaced subs, and aircraft will report any North Atlantic right whale sightings (if the whale is identifiable as a right whale) off the northeastern U.S. to Patrol and Reconnaissance Wing (COMPATRECONWING). The report will include the time of sighting, lat/long, direction of movement (if apparent) and number and description of the whale(s). In addition, vessels or aircraft that observe whale carcasses will record the location and time of the sighting and report this information as soon as possible to the regional environmental coordinator. All whale strikes must be reported. Report will include the date, time, and location of the strike; vessel course and speed; operations being conducted by the vessel; weather conditions, visibility, and sea state; description of the whale; narrative of incident; and indication of whether photos/videos were taken. Units are encouraged to take photos whenever possible. Specific mitigation measures related to activities occurring within an area of concern include the following:

5.31. Vessels will avoid head-on approach to North Atlantic right whale(s) and will maneuver to maintain at least 457 m (500 yd) of separation from any observed whale if deemed safe to do so. These requirements do not apply if a vessel‘s safety is threatened, such as when change of course would create an imminent and serious threat to person, vessel, or aircraft, and to the extent vessels are restricted in the ability to maneuver.

5.3.2. When transiting within an area of concern, vessels shall use extreme caution and operate at a safe speed so as to be able to avoid collisions with North Atlantic right whales and other marine mammals, and stop within a distance appropriate to the circumstances and conditions.

5.3.3. Speed reductions (adjustments) are required when a whale is sighted by a vessel or when the vessel is within 9 km (5 NM) of a reported new sighting less than one week old.

5.3.4. Ships transiting in the Cape Cod Bay and Great South Channel feeding areas will obtain information on recent whale sightings in the vicinity of the feeding areas. Any vessel operating in the vicinity of a North Atlantic right whale shall consider additional speed reductions as per Rule 6 of International Navigational Rules.

5.4. Additional Mitigation for Torpedo Exercises (TORPEXs) in the Northeast North Atlantic right whale feeding areas. TORPEXs in locations other than the Northeast will utilize the measures described in Section 5.1. TORPEXs conducted in the five TORPEXs training areas off of Cape Cod, which may occur in right whale feeding areas, will implement the following measures:

5.4.1. All torpedo-firing operations shall take place during daylight hours.

5.4.2. During the conduct of each test, visual surveys of the test area shall be conducted by all vessels and aircraft involved in the exercise to detect the presence of marine mammals. Additionally, trained observers shall be placed on the submarine, spotter aircraft, and the surface support vessel. All participants will be required to report sightings of any marine mammals, including negative reports, prior to torpedo firings. Reporting requirements will be outlined in the test plans and procedures written for each individual exercise, and will be emphasized as part of pre-exercise briefings conducted with all participants.

5.4.3. Observers shall receive NMFS -approved training in field identification, distribution, and relevant behaviors of marine mammals of the western north Atlantic. Currently, this training is provided by a professor at the University of Rhode Island, Graduate School of Oceanography. Observers shall fill out Standard Sighting Forms and the data will be housed at the Naval Undersea Warfare Center Division Newport (NUWCDIVNPT). Any sightings of North Atlantic right whales shall be immediately communicated to the Sighting Advisory System (SAS). All platforms shall have onboard a copy of the following:

5.4.4. The Guide to Marine Mammals and Turtles of the U.S. Atlantic and Gulf of Mexico (Wynne and Schwartz 1999).

5.4.5. The NMFS Critical Sightings Program placard.

5.4.6. Right Whales, Guidelines to Mariners placard.

5.4.7. In addition to the visual surveillance discussed above, dedicated aerial surveys shall be conducted utilizing a fixed-wing aircraft. An aircraft with an overhead wing (i.e., Cessna Skymaster or similar) will be used to facilitate a clear view of the test area. Two trained observers, in addition to the pilot, shall be embarked on the aircraft. Surveys will be conducted at an approximate altitude of 305 m (1,000 feet [ft]) flying parallel track lines at a separation of 1.85 km (1 nm), or as necessary to facilitate good visual coverage of the sea surface. While conducting surveillance, the aircraft shall maintain an approximate speed of 185 kilometers per hour (km/hr) (100 knots [kn]). Since factors that affect visibility are highly dependent on the specific time of day of the survey, the flight operator will have the flexibility to adjust the flight pattern to reduce glare and improve visibility. The entire test site will be surveyed initially, but once preparations are being made for an actual test launch, survey effort will be concentrated over the vicinity of the individual test location. Further, for approximately ten minutes immediately prior to launch, the aircraft will racetrack back and forth between the launch vessel and the target vessel.

5.4.8. Commencement of an individual torpedo test scenario shall not occur until observers from all vessels and aircraft involved in the exercise have reported to the Officer in Tactical Command (OTC) and the OTC has declared that the range is clear of marine mammals. Should protected animals be present within or seen moving toward the test area, the test shall be either delayed or moved as required to avoid interference with the animals.

5.4.9. The TORPEX will be suspended if the Beaufort Sea State exceeds 3 or if visibility precludes safe operations.

5.4.10. Vessel speeds:

- During transit through the North Atlantic right whale feeding areas, surface vessels and submarines shall maintain a speed of no more than 19 km/hr (10 km) while not actively engaged in the exercise procedures.

- During TORPEX operations, a firing vessel will likely not exceed 19 km/hr (10 km). When a submarine is used as a target, vessel speeds would not likely exceed 33 km/hr (18 km). However, on occasion, when surface vessels are used as targets, the vessel may exceed 33 km/hr (18 km) in order to fully test the functionality of the torpedoes. This increased speed would occur for a short period of time (e.g., 10 to 15 minutes) to evade the torpedo when fired upon.

- In the event of an animal strike, or if an animal is discovered that appears to be in distress, a report will immediately be promulgated through the appropriate Navy chain of Command.

1.8.1.7. Mitigation Requirements of the MMPA Letter of Authorization

When the U.S. Navy conducts the training activities identified in the Permit Division's Letter of Authorization, the final regulations and draft LOA that NMFS' Permits Division proposes to issue require the U.S. Navy to implement mitigation measures that include (but are not limited to) the following:

1. *Mitigation Measures for ASW and MIW training*:

i. All lookouts onboard platforms involved in ASW training events shall review the NMFS-approved Marine Species Awareness Training (MSAT) material prior to use of mid-frequency active sonar.

ii. All Commanding Officers, Executive Officers, and officers standing watch on the Bridge shall have reviewed the MSAT material prior to a training event employing the use of mid-frequency active sonar.

iii. Navy lookouts shall undertake extensive training in order to qualify as a watchstander in accordance with the Lookout Training Handbook (NAVEDTRA, 12968-D).

iv. Lookout training shall include on-the-job instruction under the supervision of a qualified, experienced watchstander. Following successful completion of this supervised training period, Lookouts shall complete the Personal Qualification Standard program, certifying that they have demonstrated the necessary skills (such as detection and reporting of partially submerged objects).

v. Lookouts shall be trained in the most effective means to ensure quick and effective communication within the command structure in order to facilitate implementation of mitigation measures if marine species are spotted.

vi. On the bridge of surface ships, there shall be at least three people on watch whose duties include observing the water surface around the vessel.

vii. All surface ships participating in ASW exercises shall, in addition to the three personnel on watch noted previously, have at all times during the exercise at least two additional personnel on watch as lookouts.

viii. Personnel on lookout and officers on watch on the bridge shall have at least one set of binoculars available for each person to aid in the detection of marine mammals.

ix. On surface vessels equipped with mid-frequency active sonar, pedestal mounted "Big Eye" (20x110) binoculars shall be present and in good working order.

x. Personnel on lookout shall employ visual search procedures employing a scanning methodology in accordance with the Lookout Training Handbook (NAVEDTRA 12968-D). Surface lookouts should scan the water from the ship to the horizon and be responsible for all contacts in their sector. In searching the assigned sector, the lookout should always start at the forward part of the sector and search aft (toward the back). To search and scan, the lookout should hold the binoculars steady so the horizon is in the top third of the field of vision and direct the eyes just below the horizon. The lookout should scan for approximately five seconds in as many small steps as possible across the field seen through the binoculars. They should search the entire sector in approximately five-degree steps, pausing between steps for approximately five seconds to scan the field of view. At the end of the sector search, the glasses should be lowered to allow the eyes to rest for a few seconds, and then the lookout should search back across the sector with the naked eye.

xi. After sunset and prior to sunrise, lookouts shall employ Night Lookouts Techniques in accordance with the Lookout Training Handbook. At night, lookouts should not sweep the horizon with their eyes because this method is not effective when the vessel is moving. Lookouts should scan the horizon in a series of movements that should allow their eyes to come to periodic rests as they scan the sector. When visually searching at night, they should look a little to one side and out of the corners of their eyes, paying attention to the things on the outer edges of their field of vision.

xii. Personnel on lookout shall be responsible for informing the Officer of the Deck all objects or anomalies sighted in the water (regardless of the distance from the vessel) to the Officer of the Deck, since any object or disturbance (e.g., trash, periscope, surface disturbance, discoloration) in the water may be indicative of a threat to the vessel and its crew or indicative of a marine species that may need to be avoided as warranted.

xiii. Commanding Officers shall make use of marine species detection cues and information to limit interaction with marine species to the maximum extent possible consistent with safety of the ship.

xiv. All personnel engaged in passive acoustic sonar operation (including aircraft, surface ships, or submarines) shall monitor for marine mammal vocalizations and report the detection of any marine mammal to the appropriate watch station for dissemination and appropriate action.

xv. Units shall use training lookouts to survey for marine mammals prior to commencement and during the use of active sonar.

xvi. During mid-frequency active sonar training activities, personnel shall utilize all available sensor and optical systems (such as Night Vision Goggles) to aid in the detection of marine mammals.

xvii. Navy aircraft participating in exercises at sea shall conduct and maintain, when operationally feasible and safe, surveillance for marine mammals as long as it does not violate safety constraints or interfere with the accomplishment of primary operational duties.

xviii. Aircraft with deployed sonobuoys shall use only the passive capability of sonobuoys when marine mammals are detected within 200 yards (182 m) of the sonobuoy.

xix. Marine mammal detections shall be reported immediately to assigned Aircraft Control Unit (if participating) for further dissemination to ships in the vicinity of the marine species as appropriate where it is reasonable to conclude that the course of the ship will likely result in a closing of the distance to the detected marine mammal.

xx. Safety Zones - When marine mammals are detected by any means (aircraft, shipboard lookout, or acoustically) the Navy shall ensure that MFAS transmission levels are limited to at least 6 dB below normal operating levels if any detected marine mammals are within 1000 yards (914 m) of the sonar dome (the bow).

(A) Ships and submarines shall continue to limit maximum transmission levels by this 6-dB factor until the marine mammal has been seen to leave the 1000-yd safety zone, has not been detected for 30 minutes, or the vessel has transited more than 2,000 yards (1828 m) beyond the location of the last detection.

(B) When marine mammals are detected by any means (aircraft, shipboard lookout, or acoustically) the Navy shall ensure that sonar transmission levels are limited to at least 10 dB below normal operating levels if any detected marine mammals are within 500 yards (457 m) of the sonar dome (the bow). Ships and submarines shall continue to limit maximum ping levels by this 10-dB factor until the marine mammal has been seen to leave the 500-yd safety zone, has not been detected for 30 minutes, or the vessel has transited more than 2000 yards (1828 m) beyond the location of the last detection.

(C) When marine mammals are detected by any means (aircraft, shipboard lookout, or acoustically) the Navy shall ensure that sonar transmissions cease if any detected marine mammals are within 200 yards (183 m) of the sonar dome (the bow). Sonar shall not resume until the marine mammal has been seen to leave the 200-yd safety zone, has not been detected for 30 minutes, or the vessel has transited more than 2,000 yards (1828 m) beyond the location of the last detection.

(D) If the need for power-down should arise as detailed in “Safety Zones” above, Navy shall follow the requirements as though they were operating at 235 dB – the normal operating level (i.e., the first power-down will be to 229 dB, regardless of at what level above 235 dB sonar was being operated).

xxi. Prior to start up or restart of active sonar, operators shall check that the Safety Zone radius around the sound source is clear of marine mammals.

xxii. Sonar levels (generally) - Navy shall operate sonar at the lowest practicable level, not to exceed 235 dB, except as required to meet tactical training objectives.

xxiii. Helicopters shall observe/survey the vicinity of an ASW Exercise for 10 minutes before the first deployment of active (dipping) sonar in the water.

xxiv. Helicopters shall not dip their sonar within 200 yards (183 m) of a marine mammal and shall cease pinging if a marine mammal closes within 200 yards (183 m) after pinging has begun.

xxv. Submarine sonar operators shall review detection indicators of close-aboard marine mammals prior to the commencement of ASW training activities involving active mid-frequency sonar.

xxvi. Night vision devices shall be available to all ships and air crews, for use as appropriate.

xxvii. Dolphin bowriding - if, after conducting an initial maneuver to avoid close quarters with dolphins, the ship concludes that dolphins are deliberately closing in on the ship to ride the vessel’s bow wave, no further mitigation actions would be necessary because dolphins are out of the main transmission axis of the active sonar while in the shallow-wave area of the vessel bow.

xxviii. TORPEXs conducted in the North Atlantic right whale (NARW) Great South Channel or Cape Cod Bay feeding habitats (previously referred to as northeastern NARW critical habitat) shall implement the following measures. The Great South Channel NARW feeding habitat is defined as follows: The area bounded by 41deg.40' N/69 deg.45' W; 41 deg.00' N/69 deg.05' W; 41 deg.38' N/68 deg.13' W; and 42 deg.10' N/68 deg.31' W. The Cape Cod Bay NARW feeding habitat is defined as follows: the area bounded by 42 deg. 04.8' N/70 deg.10' W; 42 deg 12' N/70 deg.15' W; 42 deg.12' N/70 deg.30' W; 41 deg.46.8' N/70 deg.30' W and on the south and east by the interior shore line of Cape Cod, Massachusetts.

(A) All torpedo-firing operations shall take place during daylight hours.

(B) During the conduct of each test, visual surveys of the test area shall be conducted by all vessels and aircraft involved in the exercise to detect the presence of marine mammals. Additionally, trained observers shall be placed on the submarine, spotter aircraft, and the surface support vessel. All participants shall report sightings of any marine mammals, including negative reports, prior to torpedo firings. Reporting requirements shall be outlined in the test plans and procedures written for each individual exercise, and shall be emphasized as part of pre-exercise briefings conducted with all participants.

(C) Observers shall receive NMFS -approved training in field identification, distribution, and relevant behaviors of marine mammals of the western north Atlantic. Observers shall fill out Standard Sighting Forms and the data shall be housed at the Naval Undersea Warfare Center Division Newport (NUWCDIVNPT). Any sightings of North Atlantic right whales shall be immediately communicated to the Sighting Advisory System (SAS). All platforms shall have onboard a copy of:

(1) The Guide to Marine Mammals and Turtles of the US Atlantic and Gulf of Mexico (Wynne and Schwartz 1999)

(2) The NMFS Critical Sightings Program placard

(3) Right Whales, Guidelines to Mariners placard

(D). In addition to the visual surveillance discussed above, dedicated aerial surveys shall be conducted utilizing a fixed-wing aircraft. An aircraft with an overhead wing (i.e., Cessna Skymaster or similar) shall be used to facilitate a clear view of the test area. Two trained observers, in addition to the pilot, shall be embarked on the aircraft. Surveys shall be conducted at an approximate altitude of 1000 ft (305 m) flying parallel track lines at a separation of 1 nm (1.85 km), or as necessary to facilitate good visual coverage of the sea surface. While conducting surveillance, the aircraft shall maintain an approximate speed of 100 knots (185 km/hr). Since factors that affect visibility are highly dependent on the specific time of day of the survey, the flight operator will have the flexibility to adjust the flight pattern to reduce glare and improve visibility. The entire test site shall be surveyed initially, but once preparations are being made for an actual test launch, survey effort shall be concentrated over the vicinity of the individual test location. Further, for approximately ten minutes immediately prior to launch, the aircraft shall racetrack back and forth between the launch vessel and the target vessel.

(E) Commencement of an individual torpedo test scenario shall not occur until observers from all vessels and aircraft involved in the exercise have reported to the Officer in Tactical Command (OTC) and the OTC has declared that the range is clear of marine mammals. Should marine mammals be present within or seen moving toward the test area, the test shall be either delayed or moved as required to avoid interference with the animals.

(F) The TORPEX shall be suspended if the Beaufort Sea State exceeds 3 or if visibility precludes safe operations.

(G) Vessel speeds:

(1) During transit through the northeastern North Atlantic right whale feeding area, surface vessels and submarines shall maintain a speed of no more than 10 knots (19 km/hr) while not actively engaged in the exercise procedures.

(2) During TORPEX operations, a firing vessel should, where feasible, not exceed 10 knots. When a submarine is used as a target, vessel speeds should, where feasible, not exceed 18 knots. However, on occasion, when surface vessels are used as targets, the vessel may exceed 18 kts in order to fully test the functionality of the torpedoes. This increased speed would occur for a short period of time (e.g., 10-15 minutes) to evade the torpedo when fired upon.

(H) In the event of an animal strike, or if an animal is discovered that appears to be in distress, the Navy shall immediately report the discovery through the appropriate Navy chain of Command.

xxviii. The Navy shall abide by the following additional measures:

(A) The Navy shall avoid planning major exercises in the specified planning awareness areas (PAAs - see Figure 2 of regulations) where feasible. Should national security require the conduct of more than four major exercises (COMPTUEX, JTFEX, SEASWITI, or similar scale event) in these areas (meaning all or a portion of the exercise) per year the Navy shall provide NMFS with prior notification and include the information in any associated after-action or monitoring reports.

(B) The Navy shall conduct no more than one of the four above-mentioned major exercises (COMPTUEX, JTFEX, SEASWITI or similar scale event) per year in the Gulf of Mexico to the extent operationally feasible. If national security needs require more than one major exercise to be conducted in the Gulf of Mexico PAAs, the Navy shall provide NMFS with prior notification and include the information in any associated after-action or monitoring reports.

(C) The Navy shall include the PAAs in the Navy's Protective Measures Assessment Protocol (PMAP) (implemented by the Navy for use in the protection of the marine environment) for unit level situational awareness (i.e., exercises other than COMPTUEX, JTFEX, SEASWITI) and planning purposes.

(D) Helicopter Dipping Sonar - Unless otherwise dictated by national security needs, the Navy shall minimize helicopter dipping sonar activities within the NARW calving and rearing habitat (hereinafter "calving habitat", and previously referred to as southeastern NARW critical habitat) from November 15 – April 15. NARW calving habitat is defined as follows: The coastal waters between 31 deg.15' N and 30 deg.15' N from the coast out 15 nautical miles; and the coastal waters between 30 deg.15' N and 28 deg.00' N from the coast out 5 nautical miles. All mitigation measures described in this LOA that apply to the calving habitat are in effect from November 15 – April 15 and also apply to an associated area of concern which extends 9 km (5 NM) seaward of the designated calving habitat boundaries.

(E) Object Detection Exercises – The Navy shall implement the following measures regarding object detection activities in the southeastern areas of the North Atlantic right whale calving area:

(1) The Navy shall reduce the time spent conducting object detection exercises in the NARW calving area;

(2) Prior to conducting surface ship object detection exercises in the southeastern areas of the North Atlantic right whale calving during the time of November 15 – April 15, ships shall contact FACSFACJAX to obtain the latest North Atlantic right whale sighting information. FACSFACJAX shall advise ships of all reported whale sightings in the vicinity of the calving area and associated areas of concern (which extend 9 km (5 nm) seaward of the calving area boundaries). To the extent operationally feasible, ships shall avoid conducting training in the vicinity of recently sighted North Atlantic right whales. Ships shall maneuver to maintain at least 500 yards separation from any observed whale, consistent with the safety of the ship.

xxvii The Navy shall abide by the letter of the "Stranding Response Plan for Major Navy Training Exercises in the AFAST Study Area" to include the following measures:

(A) Shutdown Procedures– When an Uncommon Stranding Event (USE – as defined in the regulations) occurs during a Major Training Exercise (MTE, including SEASWITI, IAC, Group Sails, JTFEX, or COMPTUEX) in the AFAST Study Area, the Navy shall implement the procedures described below.

(1) The Navy shall implement a Shutdown (as defined in the regulations) when advised by a NMFS Office of Protected Resources Headquarters Senior Official designated in the AFAST 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 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 of any species other than North Atlantic right whale 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 behaviors (if alive), and photo or video (if available). Based on the information provided, NMFS shall determine if, and advise the Navy whether a modified shutdown is appropriate on a case-by-case basis.

(4) If the Navy finds an injured (or entangled) North Atlantic right whale floating at sea during an MTE, the Navy shall implement shutdown procedures (14 or 17 nm, for East Coast and Gulf of Mexico, respectively) around the animal immediately (without waiting for notification from NMFS). The Navy shall then notify NMFS (pursuant to the AFAST Communication Protocol) 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 behaviors (if alive), and photo or video (if available). Subsequent to the discovery of the injured whale, any Navy platforms in the area shall report any North Atlantic right whale sightings to NMFS (or to a contact that can alert NMFS as soon as possible). Based on the information provided, NMFS may initiate/organize an aerial survey (which may include Navy's assistance in accordance with the Memorandum of Understanding (MOU) or by other available means) to see if other North Atlantic right whales are in the vicinity. Based on the information provided by the Navy and, if necessary, the outcome of the aerial surveys, NMFS shall determine whether a continued shutdown is appropriate on a case-by-case basis. Though it will be determined on a case-by-case basis after Navy/NMFS discussion of the situation, NMFS anticipates that the shutdown will continue within 14 or 17 nm (for East Coast and Gulf of Mexico, respectively) of a live, injured/entangled North Atlantic right whale until the animal dies or has not been seen for at least 3 hours (either by NMFS staff attending the injured animal or Navy personnel monitoring the area around where the animal was last sighted).

(5) If the Navy finds a dead North Atlantic right whale floating at sea during an MTE, the Navy shall notify NMFS (pursuant to AFAST Stranding Communication Protocol) 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 behaviors (if alive), and photo or video (if available). Subsequent to the discovery of the dead whale, if the Navy is operating sonar in the area they shall use increased vigilance (in looking for North Atlantic right whales) and all platforms in the area shall report sightings of North Atlantic right whales to NMFS as soon as possible. Based on the information provided, NMFS may initiate/organize an aerial survey (which may include Navy's assistance in accordance with the Memorandum of Understanding (MOU) or by other available means) to see if other North Atlantic right whales are in the vicinity. Based on the information provided by the Navy and, if necessary, the outcome of the aerial surveys, NMFS will determine whether any additional mitigation measures are necessary on a case-by-case basis.

(6) In the event, following a USE, that: a) qualified individuals are attempting to herd animals back out to the open ocean and animals are not willing to leave, or b) 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 MFAS/HFAS training activities or explosive detonations, though farther than 14 nm 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 AFAST Communication Protocol) regarding the location, number and types of acoustic/explosive sources, direction and speed of units using MFAS/HFAS, and marine mammal sightings information associated with training activities occurring within 80 nm (148 km) and 72 hours prior to the USE event. Information not initially available regarding the 80 nm (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.

2. Mitigation for IEER/AEER - The following mitigation measures shall be used with the employment of Improved Extended Echo Ranging/Advanced Extended Echo Ranging (IEER/AEER) sonobuoys

i. Navy crews shall conduct aerial visual reconnaissance of the drop area prior to laying their intended sonobuoy pattern. This search should be conducted below 500 yards (457 m) at a slow speed, if operationally feasible and weather conditions permit. In dual aircraft training activities, crews are allowed to conduct coordinated area clearances.

ii. For IEER (AN/SSQ-110A), Navy crews shall conduct a minimum of 30 minutes of visual and acoustic monitoring of the search area prior to commanding the first post detonation. This 30-minute observation period may include pattern deployment time.

iii. For any part of the intended sonobuoy pattern where a post (source/receiver sonobuoy pair) will be deployed within 1,000 yards (914 m) of observed marine mammal activity, deploy the receiver ONLY (i.e., not the source) and monitor while conducting a visual search. When marine mammals are no longer detected within 1,000 yards (914 m) of the intended post position, the source sonobuoy (AN/SSQ-110A/SSQ-125) will be co-located with the receiver.

iv. When operationally feasible, crews will conduct continuous visual and aural monitoring of marine mammal activity. This shall include monitoring of aircraft sensors from the time of the first sensor placement until the aircraft have left the area and are out of RF range of these sensors.

v. Aural Detection: If the presence of marine mammals is detected aurally, then that shall cue the aircrew to increase the diligence of their visual surveillance. Subsequently, if no marine mammals are visually detected, then the crew may continue multi-static active search.

vi. Visual Detection:

(A) If marine mammals are visually detected within 1,000 yards (914 m) of the explosive source sonobuoy (AN/SSQ-110A/SSQ-125) intended for use, then that payload shall not be activated Aircrews may utilize this post once the marine mammals have not been re-sighted for 30 minutes, or are observed to have moved outside the 1,000 yards (914 m) safety buffer.

(B) Navy Aircrews may shift their multi-static active search to another post, where marine mammals are outside the 1,000 yards (914 m) safety buffer.

vii. For IEER (AN/SSQ-110A), Navy Aircrews shall make every attempt to manually detonate the unexploded charges at each post in the pattern prior to departing the operations area by using the “Payload 1 Release” command followed by the “Payload 2 Release” command.

Aircrews shall refrain from using the “Scuttle” command when two payloads remain at a given post. Aircrews shall ensure that a 1,000 yard (914 m) safety buffer, visually clear of marine mammals, is maintained around each post as is done during active search operations.

viii. Aircrews shall only leave posts with unexploded charges in the event of a sonobuoy malfunction, an aircraft system malfunction, or when an aircraft must immediately depart the area due to issues such as fuel constraints, inclement weather, and in-flight emergencies. In these cases, the sonobuoy will self-scuttle using the secondary or tertiary method.

ix. The Navy shall ensure all payloads are accounted for. Explosive source sonobuoys (AN/SSQ-110A) that cannot be scuttled shall be reported as unexploded ordnance via voice communications while airborne, then upon landing via naval message.

x. Marine mammal monitoring shall continue until out of own-aircraft sensor range.

3. Mitigation Measures related to Vessel Transit and North Atlantic Right Whales

i. Mid-Atlantic, Offshore of the Eastern United States

(A). All Navy vessels are required to use extreme caution and operate at a slow, safe speed consistent with mission and safety during the months indicated below and within a 37 km (20 nm) arc (except as noted) of the specified associated reference points:

(1) South and East of Block Island (37 km (20 NM) seaward of line between 41-4.49 N. lat. 071-51.15 W. long. and 41-18.58 N. lat. 070-50.23 W. long): Sept-Oct and Mar-Apr

(2) New York / New Jersey (40-30.64 N. lat. 073-57.76 W. long.): Sep–Oct and Feb-Apr.

(3) Delaware Bay (Philadelphia) (38-52.13 N. lat. 075-1.93 W. long.): Oct–Dec and Feb–Mar.

(4) Chesapeake Bay (Hampton Roads and Baltimore) (37-1.11 lat. 075-57.56 W. long.): Nov-Dec and Feb–Apr.

(5) North Carolina (34-41.54 N. lat. 076-40.20 W. long.): Dec-Apr

(6) South Carolina (33-11.84 N. lat. 079-8.99 W. long. and 32-43.39 N. lat. 079-48.72 W. long.): Oct-Apr

(B) During the months indicated in (A), above, Navy vessels shall practice increased vigilance with respect to avoidance of vessel-whale interactions along the mid-Atlantic coast, including transits to and from any mid-Atlantic ports not specifically identified above.

(C) All surface units transiting within 56 km (30 NM) of the coast in the mid-Atlantic shall ensure at least two watchstanders are posted, including at least one lookout who has completed required MSAT training.

(D) Navy vessels shall not knowingly approach any whale head on and shall maneuver to keep at least 457 m (1,500 ft) away from any observed whale, consistent with vessel safety.

ii. Southeast Atlantic, Offshore of the Eastern United States – for the purposes of the measures below (within (ii)), the “southeast” encompasses sea space from Charleston, South Carolina, southward to Sebastian Inlet, Florida, and from the coast seaward to 148 km (80 NM) from shore.

(A) Prior to transiting or training in the calving habitat or associated area of concern, ships shall contact Fleet Area Control and Surveillance Facility, Jacksonville, to obtain latest whale sighting and other information needed to make informed decisions regarding safe speed and path of intended movement. Subs shall contact Commander, Submarine Group Ten for similar information.

(B) The following specific mitigation measures apply to activities occurring within the calving area and an associated area of concern which extends 9 km (5 nm) seaward of the designated calving habitat boundaries:

(1) When transiting within the calving habitat or associated area of concern, 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 whale is sighted by a vessel or when the vessel is within 9 km (5 nm) of a reported new sighting less than 12 hours old. Circumstances could arise where, in order to avoid North Atlantic right whale(s), speed reductions could mean vessel must reduce speed to a minimum at which it can safely keep on course or vessels could come to an all stop.

(3) Vessels shall avoid head-on approaches to North Atlantic right whale(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 the ability to maneuver.

(4) Ships shall not transit through the calving habitat or associated area of concern in a North-South direction.

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

iii. Northeast Atlantic, Offshore of the Eastern United States

(A) Prior to transiting the NARW Great South Channel or Cape Cod Bay feeding habitat, ships shall obtain the latest North Atlantic right whale sightings and other information needed to make informed decisions regarding safe speed.

(B) Ships, surfaced subs, and aircraft shall report any North Atlantic right whale sightings (if the whale is identifiable as a right whale) off the northeastern U.S. to the Northeast right whale sighting advisory system at (978) 585-8473 or to the US Coast Guard via Channel 16. The report shall include the time of sighting, lat/long, direction of movement (if apparent) and number and description of the whale(s).

(C) Vessels or aircraft that observe whale carcasses shall record the location and time of the sighting and report this information as soon as possible through Navy's special incident reporting procedures for marine mammals. All whale strikes must be reported. This report shall include the date, time, and location of the strike; vessel course and speed; operations being conducted by the vessel; weather conditions, visibility, and sea state; description of the whale; narrative of incident; and indication of whether photos/videos were taken. Navy personnel are encouraged to take photos whenever possible.

(D) Specific mitigation measures related to activities occurring within the NARW Great South Channel or Cape Cod Bay feeding habitat or the NARW feeding habitat include the following:

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

(2) When transiting within the feeding habitat or associated area of concern, vessels shall use extreme caution and operate at a safe speed so as to be able to avoid collisions with North Atlantic right whales and other marine mammals, and stop within a distance appropriate to the circumstances and conditions.

(3) Speed reductions (adjustments) are required when a whale is sighted by a vessel or when the vessel is within 9 km (5 nm) of a reported new sighting less than one week old.

(4) Ships transiting in the Cape Cod Bay and Great South Channel feeding habitat shall obtain information on recent whale sightings in the vicinity of the habitat. Any vessel operating in the vicinity of a North Atlantic right whale shall consider additional speed reductions as per Rule 6 of International Navigational Rules.

The Permits Division included the following monitoring and reporting requirements in its 2011 Letter of Authorization for AFAST:

a. As outlined in the AFAST Stranding Communication Plan, the Navy must notify NMFS immediately (or as soon as clearance procedures allow) if the specified activity identified in 50 CFR § 216.240(c) is thought to have resulted in the mortality or injury of any marine mammals, or in any take of marine mammals not identified in 50 CFR § 216.242(c).

b. The Navy must implement the AFAST Monitoring Plan.

c. The Navy shall continue to comply with the 2009 Integrated Comprehensive Monitoring Program (ICMP) Plan and continue to improve the program in consultation with NMFS.

d. 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, any Navy training exercise utilizing MFAS, HFAS, or underwater explosive detonations. 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 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.

e. Annual AFAST Monitoring Plan Report - The Navy shall submit a report October 1, 2011 describing the implementation and results (through August 1 of the same year) of the AFAST Monitoring Plan, described above. The report will also include any analysis conducted or conclusions reached based on the previous year's data that were not completed in time for the previous year's monitoring report. Data collection methods will be standardized across range complexes to allow for comparison in different geographic locations. Although additional information will be gathered, the marine mammal observers (MMOs) collecting marine mammal data pursuant to the AFAST Monitoring Plan shall, at a minimum, provide the same marine mammal observation data required in the data required in 218.85(f)(1). The AFAST Monitoring Plan Report may be provided to NMFS within a larger report that includes the required Monitoring Plan Reports from AFAST and multiple Range Complexes

f. Annual AFAST Exercise Report - The Navy shall submit an Annual AFAST Exercise Report on October 1 of every year (covering data gathered through August 1 of the same year). This report shall contain information identified in subsections 216.245(f)(1) – (f)(3).

(1) MFAS/HFAS Major Training Exercises - This section shall contain the following information for the major training exercises for reporting (MTERs), which include the Southeastern ASW Integrated Training Initiative (SEASWITI), Integrated ASW Course (IAC), Composite Training Unit Exercises (COMPTUEX), and Joint Task Force Exercises (JTFEX) conducted in the AFAST Study Area:

(i) Exercise Information (for each MTER):

(A) Exercise designator

(B) Date that exercise began and ended

(C) Location

(D) Number and types of active sources used in the exercise

(E) Number and types of passive acoustic sources used in exercise

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

(G) Total hours of observation by watchstanders

(H) Total hours of all active sonar source operation

(I) Total hours of each active sonar source (along with explanation of how hours are calculated for sources typically quantified in alternate way (buoys, torpedoes, etc.)).

(J) Wave height (high, low, and average during exercise)

(ii). Individual marine mammal sighting info (for each sighting in each MTER)

(A) Location of sighting

(B) Species (if not possible – indication of whale/dolphin/pinniped)

(C) Number of individuals

(D) Calves observed (y/n)

(E) Initial Detection Sensor

(F) Indication of specific type of platform observation made from (including, for example, what type of surface vessel, i.e., FFG, DDG, or CG)

(G) Length of time observers maintained visual contact with marine mammal

(H) Wave height (in feet)

(I) Visibility

(J) Sonar source in use (y/n).

(K) Indication of whether animal is <200yd, 200-500yd, 500-1000yd, 1000-2000yd, or >2000yd from sonar source in (x) above.

(L) Mitigation Implementation – Whether operation of sonar sensor was delayed, or sonar was powered or shut down, and how long the delay was.

(M) If source in use (J) is hullmounted, true bearing of animal from ship, true direction of ship's travel, and estimation of animal's motion relative to ship (opening, closing, parallel)

(N) 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.)

(iii) An evaluation (based on data gathered during all of the MTERs) of the effectiveness of mitigation measures designed to avoid exposing to MFAS. This evaluation shall identify the specific observations that support any conclusions the Navy reaches about the effectiveness of the mitigation.

(2) ASW Summary - This section shall include the following information as summarized from both MTEs and non-major training exercises (i.e., unit-level exercises):

(i) Total annual hours of each type of sonar source (along with explanation of how hours are calculated for sources typically quantified in alternate way (buoys, torpedoes, etc.))

(ii) To the extent practicable, the Navy, in coordination with NMFS, shall develop and implement a method of annually reporting non-major (i.e., other than MTERs) training exercises utilizing hull-mounted sonar. The report shall present an annual (and seasonal, where practicable) depiction of non-major training exercises geographically across the AFAST Study Area. To the extent practicable, this report will also include the total number of sonar hours (from helicopter dipping sonar and object detection exercises) conducted within the NARW calving habitat plus 5 nm buffer area). The Navy shall include (in the AFAST annual report) a brief annual progress update on the status of the development of an effective and unclassified method to report this information until an agreed-upon (with NMFS) method has been developed and implemented.

(3) IEER Summary. This section shall include an annual summary of the following IEER information:

(i) Total number of IEER events conducted in AFAST

(ii) Total expended/detonated rounds (buoys)

(iii) Total number of self-scuttled IEER rounds

g. Sonar Exercise Notification - The Navy shall submit to the NMFS Office of Protected Resources (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 (COMPTUEX, JTFEX, or SEASWITI) indicating:

(1) Location of the exercise

(2) Beginning and end dates of the exercise

(3) Type of exercise (e.g., COMPTUEX or SEASWITI)

i. AFAST 5-yr Comprehensive Report - The Navy shall submit to NMFS a draft report that analyzes and summarizes all of the multi-year marine mammal information gathered during ASW and explosive exercises for which annual reports are required (Annual AFAST Exercise Reports and AFAST Monitoring Plan Reports). This report will be submitted at the end of the fourth year of the rule (November 2012), covering activities that have occurred through June 1, 2012.

j. Comprehensive National ASW Report - By June 2014, the Navy shall submit a draft Comprehensive National Report that analyzes, compares, and summarizes the active sonar data gathered (through January 1, 2014) from the watchstanders and pursuant to the implementation of the Monitoring Plans for the AFAST, SOCAL, the HRC, the Marianas Range Complex, the Northwest Training Range, and the Gulf of Alaska.

k. The Navy shall respond to NMFS comments and requests for additional information or clarification on the AFAST Comprehensive Report, the draft National ASW report, the Annual AFAST Exercise Report, or the Annual AFAST Monitoring Plan Report (or the multi-Range Complex Annual Monitoring Plan Report, if that is how the Navy chooses to submit the information) if submitted within 3 months of receipt. These reports will be considered final after the Navy has addressed NMFS' comments or provided the requested information, or three months after the submittal of the draft if NMFS does not comment by then.

q. In 2011, the Navy shall convene a Monitoring Workshop in which the Monitoring Workshop panelists will be asked to review the Navy's Monitoring Plans and monitoring results and make individual recommendations (to the Navy and NMFS) of ways of improving the Monitoring Plans. The recommendations shall be reviewed by the Navy, in consultation with NMFS, and modifications to the Monitoring Plan shall be made, as appropriate.

Table 4. Training scenarios and the number of activities associated with those scenarios, by operating area

Training Scenario	Operating Area					
	Northeast	Virginia Capes	Cherry Point	Jacksonville – Charleston	Gulf of Mexico	Totals
Independent Unit-Level Training						
Surface Ship ASW	-	69	91	292	5	**457**
Surface Ship Object Detection/Navigational Sonar	-	68	-	40	-	**108**
Helicopter ASW	-	25	25	115	-	**165**
Submarine ASW	30	10	14	45	1	**100**
Submarine Object Detection/Navigational Sonar	165	78	-	57	-	**300**
Maritime Patrol Aircraft ASW (tonal sonobuoy)	238	79	111	356	7	**791**
Maritime Patrol Aircraft ASW (explosive source sonobuoy)	34	34	34	34	34	**170**
Surface Ship Mine Warfare Exercise	-	-	-	-	266	**266**
Coordinated Unit-Level Training						
SEASWITI	-	-	-	4	-	**4**
IAC	-	0.2	1.4	2.4	1	**5**
Group Sail	-	3	4	13	-	**20**
SCC Operations	0.4	-	-	1.6	-	**2**
RONEX and GOMEX Exercises	-	-	-	-	8	**8**
Strike Group Training						
ESG and CSG Composite Training Unit Exercise	-	0.2	1.4	2.4	1	**5**
Joint Task Force Exercise	-	0.2	0.6	1.2	0	**2**
Maintenance						
Surface Ship Sonar Maintenance	-	61	82	263	4	**410**
Submarine Sonar Maintenance	30	10	14	45	1	**100**
Event Totals	**497.4**	**437.6**	**378.4**	**1271.6**	**328**	**2913**

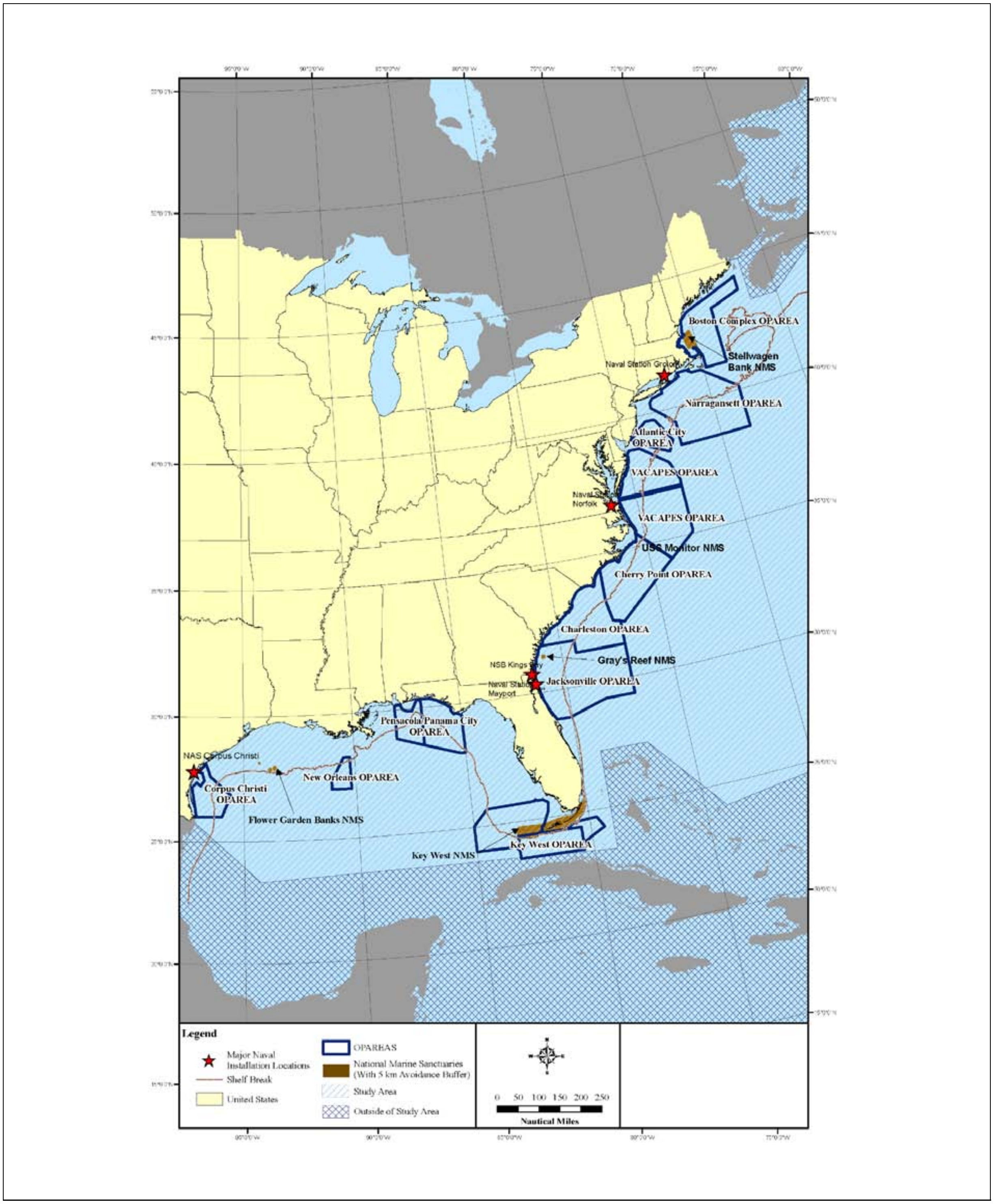

Figure 4. The action area for the U.S. Navy's Atlantic Fleet Active Sonar Training

1.8.2 Undersea Warfare Training Range

NMFS considered the direct and indirect effects of the U.S. Navy's proposed Undersea Warfare Training Range in a biological opinion we issued in July of 2009. However, we discuss those activities in this consultation because the proposed training range would be installed on a portion of the Jacksonville Range Complex and some of the training activities we consider in this consultation would occur on that training range, once the range becomes operational. Although the Undersea Warfare Training Range is not scheduled to become operational until 2015 and activities associated with the installation and operation of the training range do not overlap with the 2010 LOA, we describe the training range in these Opinions in the interests of completeness and consistency.

Between 2014 and 2019, the U.S. Navy proposes to place a network of underwater transducer devices and undersea cables in a 1,713-km2 (500 nautical mile2) area of the ocean about 93 km (50 nautical miles) offshore of northeastern Florida. The instrumented area would be connected by cable to a facility that would be located on shore where the data collected on the range would be used to evaluate the performance of participants in shallow water training exercises. The proposed action would require logistical support for anti-submarine warfare training, including training with a variety of non-explosive exercise weapons, target submarine simulators, and other associated hardware. Once this area has been instrumented, the U.S. Navy plans to use this area for anti-submarine warfare training.

Specifically, the proposed Undersea Warfare Training Range consists of five primary elements:

1. Not more than 300 underwater acoustic devices, or transducer nodes that would be placed on the ocean floor and would be capable of both transmitting and receiving acoustic signals from ships operating within the Undersea Warfare Training Range.

   Transducer nodes would be either dome-shaped or tethered (the shape of the nodes and their configuration would be designed to be consistent with local conditions and to accommodate activities in the area, such as fishing). Distances between nodes would vary from 2 to 6 km (1 to 3 nautical miles) depending on water depth.

   Nodes would be connected with commercial fiber optic undersea cable (interconnect cable), which would have a diameter of about 2.5 cm [0.98 in] in diameter), similar to that used by the telecommunications industry. About 1,110 km (600 nautical miles) of cable would be used to connect the nodes.

2. Internode cable to connect nodes to a junction box. This cable may or may not be buried depending on activities that might interact with the bottom in a particular location (for example,

anchoring and extensive use of bottom-dragged fishing gear). Cable that is not buried would be designed to lie on the ocean bottom; the system has been designed to avoid the use of cable suspensions (i.e., cable extending above the ocean bottom).

3. A junction box located at the edge of the Undersea Warfare Training Range would connect the interconnect cables with the trunk cable. Installation of the junction box would impact an area of about 30 m2 (523 ft2).

4. A buried trunk cable that connects the junction box to a Cable Termination Facility that would be located on-shore at Naval Station – Mayport. The trunk cable would be about 100 km (62 mi) in length and approximately 3 to 6 cm (1 to 3 in) in diameter. From the Cable Termination Facility, the trunk cable would be buried in an excavated trench to a point just upland of either sand dunes or an impassable physical feature (such as a highway). The trunk cable would then run through an subsurface conduit, which would be installed by horizontal directional drilling.

The conduit would extend from the end of the trench, underneath the dunes, beach, and shoreline, to a point approximately 915 m (3,000 ft) offshore of the mean low water line. The offshore exit point of the conduit may be secured to the ocean bottom with an anchor.

From the conduit exit point to the junction box, the cable would be buried to a depth of 0.5 to 1 m (1 to 3 ft) in a trench 10 cm (4 in) wide. The trench would be excavated by a tracked, remotely operated cable burial vehicle that is approximately 5 m (16 ft) in width.

Acoustic signals that would be transmitted from participants in exercises that would be conducted on the proposed Training Range would allow the U.S. Navy to determine the position of the participants and make it possible for the U.S. Navy to evaluate those data during and following training events.

Installation Methods

The U.S. Navy proposes to employ installation ships to install each node. During the installation process, the ship would reduce speed or stop to maneuver the device into the water and onto the ocean bottom. The ship would then resume the cable installation until the full system had been set in place. Throughout the installation, observers would be located on both the deck and bridge of the ship to monitor the progress and equipment. The U.S. Navy would not make underwater observations of the cable or nodes during installation but would monitor the operation electronically.

Installation of the cables associated with the Undersea Warfare Training Range would use equipment and techniques commonly used by the telecommunications industry for phone and data cables. The installation ship would proceed slowly (1 to 3.7 km per hour [0.5 to 2 nautical miles per hour]) along the desired cable route. Based on this speed, the ship would install 1 km (0.54 nautical miles) of cable in as little as 16 minutes or as much as 60 minutes.

Trenching equipment would be used in hard bottom areas to cut a furrow approximately 10 cm (0.3 ft) wide and about 90 cm (3 ft) deep, into which the cable would be placed. The cable installation process would involve the excavation of pieces of hard substrate that are pushed aside by the cutter head in the immediate surrounding area of the furrow. In soft sediment, the cable would be buried about 90 cm (3 ft) deep using jetting or a plow. In jetting, the soil is "liquefied" by the jetting process and then dispersed into the water column. In a short period of time, the fine sediment would then settle back to the ocean bottom. The plowing process is similar to trenching, except the plow uses the newly disturbed sediment as a backfill to cover the trench.

The U.S. Navy designed the Undersea Warfare Training Range to have an operational life of 20 years with a minimum need for maintenance and repair. The use of materials capable of withstanding long-term exposure to high water pressure and salt water-induced corrosion is also important. Cables may be periodically inspected by divers or undersea vehicles to ensure they remain buried and to monitor the recovery of the areas that have been disturbed.

When the range instrumentation is no longer necessary, it will be left in place to avoid the environmental effects that would result from their removal. The U.S. Navy would re-use the Cable Termination Facility, as appropriate.

Training in the Undersea Warfare Training Range

The principal type of exercise conducted on the Undersea Warfare Training Range would be anti-submarine warfare. A wide range of ships, submarines, aircraft, non-explosive exercise weapons, and other training-related devices are used for anti-submarine warfare training. Submarines, surface ships, and aircraft all conduct anti-submarine warfare and would be the principal users of the range. The requirements of threat realism on the Undersea Warfare Training Range necessitate training with a variety of sensors, non-explosive exercise weapons, target submarine simulators, and other associated hardware. Many of the materials used on the Undersea Warfare Training Range would be recovered after use; although some would be left in place. All ordnance used would be non-explosive.

Antisubmarine Warfare

Either individually or as a coordinated force, submarines, surface ships, and aircraft conduct anti-submarine warfare against submarine targets. Submarine targets include both actual submarines and other mobile targets that simulate the operations and signature characteristics of an actual submarine. anti-submarine warfare exercises are complex and highly variable. These exercises have been grouped into the four representative scenarios described below in order to best characterize them for environmental impact analysis purposes.

Scenario 1: One Aircraft vs. One Submarine. The range operations center gives an aircraft (helicopter or fixed-wing) the approximate, or “last known,” location of the submarine. An aircraft flies over the range area and the crew conducts a localized search for a target submarine using available sensors. After the aircrew detects the submarine, it simulates an attack. Each additional attack phases are conducted with simulated torpedo firings.

Scenario 2: One Ship with Helicopter vs. One Submarine. A ship, with a helicopter on board, approaches the range area and launches its helicopter to conduct a “stand-off” localization and attack. In some exercises, the ship conducts its own “close in” attack simulation (i.e., where the ship gets close enough to track the submarine using its own hull-mounted sonar). Each exercise period typically involves the firing of one exercise torpedo by the ship or helicopter or, in some cases, by both. Some ships carry two helicopters, but only one participates in the exercise at any one time. While the ship is searching for the submarine, the submarine may practice simulated attacks against the target and on average would launch exercise torpedoes or recoverable exercise torpedoes during 50 percent of the exercises.

Scenario 3: One Submarine vs. Another Submarine. Two submarines on the range practice locating and attacking each other. If only one submarine is available for the exercise, it practices attacks against a target simulator or a range support boat, or it practices shallow water maneuvers without any attack simulation

Scenario 4: Two Ships and Two Aircraft vs. One Submarine. This scenario involves the same action as Scenario 2, but with two ships and two aircraft – helicopters or marine patrol aircraft – searching for, locating, and attacking one submarine. Typically, one ship and one aircraft are actively prosecuting while the other ship and the other aircraft are repositioning. While the ships are searching for the submarine, the submarine may practice simulated attacks against the ships and on average would launch torpedoes during 50 percent of the exercises. Multiple sources may be active at one time. Scenario 4 is operationally the busiest exercise on the range.

Proposed Protective Measures

The U.S. Navy proposes to employ a suite of measures that are designed to protect marine mammals and sea turtles from being exposed to the training activities the U.S. Navy plans to conduct on the Undersea Warfare Training Range.

Navy shipboard lookouts are highly qualified and experienced marine observers. At all times, the shipboard lookouts are required to sight and report all objects found in the water to the Officer of the Deck (OOD). Objects (e.g., trash, periscope) or disturbances (e.g., surface disturbance, discoloration) in the water may indicate a threat to the vessel and its crew. Navy lookouts undergo extensive training to qualify as a lookout. This training includes on-the-job instruction under the supervision of an experienced lookout, followed by completion of the Personal Qualification Standard program, certifying that they have demonstrated the necessary skills to detect and report partially submerged objects. In addition to these requirements, many lookouts periodically undergo a two-day refresher training course.

Marine mammal mitigation training for those who would use the proposed Undersea Warfare Training Range is a key element of the mitigation measures. The goal of this training is two-fold:

- That Undersea Warfare Training Range personnel operating the active sonar understand the details of the mitigation measures and be competent to carry out these measures.

- That key personnel onboard Navy platforms exercising in the proposed Undersea Warfare Training Range understand the mitigation measures and be competent to carry them out.

For the past few years, the Navy has implemented marine mammal spotter training for its bridge lookout personnel on ships and submarines. This training has been revamped and updated as the Marine Species Awareness Training (MSAT) and is provided to all applicable units. The lookout training program incorporates MSAT, which addresses the lookout's role in environmental protection, laws governing the protection of marine species, Navy stewardship commitments, and general observation information, including more detailed information for spotting marine mammals. MSAT has been reviewed by NMFS and acknowledged as suitable training. MSAT would also be provided to the following personnel:

- Bridge personnel on ships and submarines – Personnel would continue to use the current marine mammal spotting training and any updates.

- Aviation units – Pilots and air crew personnel whose airborne duties during Anti-Submarine Warfare (anti-submarine warfare) operations include searching for submarine periscopes would be trained in marine mammal spotting. These personnel would also be trained on the details of the mitigation measures specific to both their platform and that of the surface combatants with which they are operating.

- Sonar personnel on ships, submarines, and anti-submarine warfare aircraft – Sonar operators aboard ships, submarines, and aircraft operating on the proposed Undersea Warfare Training Range would be trained in the details of the mitigation measures relative to their platform.

Training would also target the specific actions to be taken if a marine mammal is observed.

General Maritime Protective Measures: Personnel Training

• All lookouts aboard platforms involved in anti-submarine warfare training activities would review the NMFS -approved MSAT material prior to the use of mid-frequency active sonar.

• All Commanding Officers, Executive Officers, and officers standing watch on the bridge, maritime patrol aircraft aircrews, and anti-submarine warfare helicopter crews will complete MSAT material prior to conducting a training activity employing mid-frequency active sonar.

• Navy lookouts would undertake extensive training in order to qualify as a lookout in accordance with the Lookout Training Handbook (Naval Education and Training Command Manual [NAVEDTRA] 12968-D).

• Lookout training would include on-the-job instruction under the supervision of a qualified, experienced lookout. Following successful completion of this supervised training period, lookouts would complete the Personal Qualification Standard program, certifying that they have demonstrated the necessary skills (such as detection and reporting of partially submerged objects). This does not forbid personnel being trained as lookouts from inclusion in previous measures as long as supervisors monitor their progress and performance.

• Lookouts would be trained to quickly and effectively communicate within the command structure in order to facilitate implementation of mitigation measures if marine species are spotted.

General Maritime Protective Measures: Lookout Responsibilities

• On the bridge of surface ships, there would always be at least three personnel on watch whose duties include observing the water surface around the vessel.

• In addition to the three personnel on watch on the bridge, all surface ships participating in anti-submarine warfare exercises would have at least two additional personnel on watch as lookouts at all times during the exercises.

• Personnel on lookout and officers on watch on the bridge shall have at least one set of binoculars available for each person to aid in the detection of marine mammals.

• On surface vessels equipped with mid-frequency active sonar, pedestal-mounted “Big Eye” (20 x 110) binoculars shall be present and would be maintained in good working order to assist in the detection of marine mammals near the vessel.

• Personnel on lookout shall follow visual search procedures employing a scanning methodology in accordance with the Lookout Training Handbook (NAVEDTRA 12968-D).

• Surface lookouts should scan the water from the ship to the horizon and be responsible for all contacts in their sector. In searching the assigned sector, the lookout should always start at the forward part of the sector and search aft (toward the back). To search and scan, the lookout should hold the binoculars steady so the horizon is in the top third of the field of vision and direct their eyes just below the horizon. The lookout should scan for approximately five seconds in as many small steps as possible across the field seen through the binoculars. They should search the entire sector through the binoculars in approximately five-degree steps, pausing between steps for approximately five seconds to scan the field of view. At the end of the sector search, the glasses would be lowered to allow the eyes to rest for a few seconds, and then the lookout should search back across the sector with the naked eye.

• After sunset and prior to sunrise, lookouts shall employ Night Lookout Techniques in accordance with the Lookout Training Handbook (NAVEDTRA 12968-D).

• At night, lookouts should not sweep the horizon with their eyes, as eyes do not perceive objects well when they are moving. Lookouts should scan the horizon in a series of short movements that would allow their eyes to come to periodic rests as they scan the sector. When visually searching at night, they should look a little to one side and out of the corners of their eyes, paying attention to the things on the outer edges of their field of vision.

• Personnel on lookout shall be responsible for informing the OOD of all objects or anomalies sighted in the water (regardless of the distance from the vessel), since any object or disturbance (e.g., trash, periscope, surface disturbance, discoloration) in the water may indicate a threat to the vessel and its crew or the presence of a marine species that may need to be avoided, as warranted.

Operating Procedures

• Helicopters shall observe/survey the vicinity of a planned anti-submarine warfare exercise ten minutes prior to dipping of sonobuoys.

• Commanding officers would make use of marine species detection cues and information to limit interaction with marine species to the maximum extent possible, consistent with the safety of the ship.

• All personnel using all instrumentation capable of passive acoustic sonar operation (including aircraft, surface ships, or submarines) shall monitor for marine mammal vocalizations and report the detection of any marine mammal to the appropriate watch station for dissemination and appropriate action. The Navy can detect sounds within the human hearing range due to an operator listening to the incoming sounds. Passive acoustic detection systems are used during all anti-submarine warfare activities.

• Units shall use trained lookouts to survey for marine mammals and sea turtles prior to commencement and during the use of active sonar.

• During operations involving active sonar, personnel shall use all available sensor and optical systems (such as night vision goggles to aid in the detection of marine mammals).

• Navy aircraft participating in exercises at sea shall conduct and maintain, when operationally feasible and safe, surveillance for marine species of concern as long as it does not violate safety constraints or interfere with the accomplishment of primary operational duties.

• Aircraft with deployed sonobuoys shall use only the passive capability of sonobuoys when marine mammals are detected within 183 m (600 ft) of the sonobuoy.

• Marine mammal detections by aircraft shall be immediately reported to the assigned Aircraft Control Unit (if participating) for further dissemination to ships in the vicinity of the marine species. This action shall occur when it is reasonable ship and the detected marine mammal.

• When marine mammals are detected by any means (aircraft, shipboard lookout, or acoustically) within 914 m (3,000 ft) of the sonar dome (the bow), the ship or submarine shall limit active transmission levels to at least 6 decibels (dB) below normal operating levels.

• Ships and submarines shall continue to limit maximum transmission levels by this 6 dB factor until the animal has been seen to leave the area, has not been detected for 30 minutes, or the vessel has transited more than 1,829 m (6,000 ft) beyond the location of the last detection.

• Should a marine mammal be detected within 457 m (1,500 ft) of the sonar dome, active sonar transmissions shall be limited to at least 10 dB below the equipment's normal operating level. Ships and submarines shall continue to limit maximum ping levels by this 10 dB factor until the animal has been seen to leave the area, has not been detected for 30 minutes, or the vessel has transited more than 1,829 m (6,000 ft) beyond the location of the last detection.

• Should the marine mammal be detected within 183 m (600 ft) of the sonar dome, active sonar transmissions shall cease. Sonar shall not resume until the animal has been seen to leave the area, has not been detected for 30 minutes, or the vessel has transited more than 1,829 m (6,000 ft) beyond the location of the last detection.

• If the need for power-down should arise, as detailed above, Navy staff shall follow the requirements as though they were operating at 235 dB - the normal operating level (i.e., the first power-down shall be to 229 dB, regardless of the level above 235 db the sonar was being operated).

• Prior to start up or restart of active sonar, operators shall check that the shut down zone radius around the sound source is clear of marine mammals.

• Sonar levels (generally) – The Navy would operate sonar at the lowest practicable level, not to exceed 235 dB, except as required to meet tactical training objectives

• Helicopters shall not dip their sonar within 183 m (600 ft) of a marine mammal and would cease pinging if a marine mammal closes within 183 m (600 ft) after pinging has begun.

• Submarine sonar operators shall review detection indicators of close-aboard marine mammals prior to the commencement of anti-submarine warfare operations involving active sonar.

• Night vision devices shall be available to all Sailors and aircrews, for use as appropriate.

Special Conditions That Would Apply to Bow-riding Dolphins

If, after conducting an initial maneuver to avoid close quarters with dolphins, the ship concludes that dolphins are deliberately closing in on the ship to ride the vessel's bow wave, no further mitigation actions are necessary. While in the shallow-wave area of the vessel bow, dolphins are out of the main transmission axis of the active sonar.

Detection Probability and Mitigation Efficacy

The probability of visually detecting a marine animal is dependent upon two things. First, the animal and the observer must be in the same place at the same time. If the animal is not present, it cannot be seen (availability bias) (Marsh and Sinclair, 1989). Second, when the animal is in a position to be detected by an observer and the observer in a position to detect the animal, the observer must perceive the animal (perception bias) (Marsh and Sinclair, 1989). The factors affecting the detection of the animal may be probabilistically quantified as *g(0)*. That is, *g(0)* represents the chance that the animal will be available for detection (i.e., on the surface and in the observer's field of view) and that the observer will perceive the animal. A *g(0)* value of 1 indicates that 100 percent of the animals are detected; it is rare that this assumption holds true, as both perception and availability bias impact the overall value of *g(0)* for any given species.

Various factors are involved in estimating *g(0)*, including: sightability/detectability of the animal (species-specific behavior and appearance, school size, blow characteristics, dive characteristics, and dive interval); viewing conditions (sea state, wind speed, wind direction, sea swell, and glare); and observer (experience, fatigue, and concentration) and platform characteristics (pitch, roll, yaw, speed, and height above water). Thomsen et al. (2005) provide a complete and recent discussion of *g(0)*, factors that affect the detectability of the animals, and ideas on how to account for detection bias. It is important to note that *g(0)* as it is used here does not relate to the ability to identify an animal on any order, only that the animal will be detected.

Responses to Stranding or Unusual Mortality Events

The Navy proposes to coordinate with the local NMFS Stranding Coordinator for any unusual marine mammal behavior and any stranding, beached live/dead or floating marine mammals that may occur at any time during or within 24 hours after completion of mid-frequency active sonar use associated with anti-submarine warfare training activities. The Navy proposes to submit a report to the Office of Protected Resources, NMFS, within 120 days of the completion of a Major Exercise. This report must contain a discussion of the nature of the effects, if observed, based on both modeled results of real-time events and sightings of marine mammals.

In combination with previously discussed mitigation and protective measures, exercise-specific implementation plans developed under the ICMP will ensure thorough monitoring and reporting of Undersea Warfare Training Range training activities. A Letter of Instruction, Mitigation Measures Message, or Environmental Annex to the Operational Order will be issued prior to each exercise to further disseminate the personnel training requirement and general marine mammal protective measures including monitoring and reporting.

The Navy shall abide by the Stranding Response Plan to include the following measures: (A) Shutdown Procedures– When an Uncommon Stranding Event (USE – as defined in the regulations) occurs during a Major Training Exercise the Navy shall implement the procedures described below.

1. The Navy shall implement a Shutdown (as defined in the regulations) when advised by a NMFS Office of Protected Resources Headquarters Senior Official designated in the 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 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 of any species other than North Atlantic right whale floating at sea during an MTE[4], 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 behaviors (if alive), and photo or video (if available). Based on the information provided, NMFS shall determine if, and advise the Navy whether, a modified shutdown is appropriate on a case-by-case basis.

4. If the Navy finds an injured (or entangled) North Atlantic right whale floating at sea during an MTE, the Navy shall implement shutdown procedures 14 nmi (26 km) around the animal immediately (without waiting for notification from NMFS). The Navy shall then notify NMFS (pursuant to the Communication Protocol) 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 behaviors (if alive), and photo or video (if available). Subsequent to the discovery of the injured whale, any Navy platforms in the area shall report any North Atlantic right whale sightings to NMFS (or to a contact that can alert NMFS as soon as possible). Based on the information provided, NMFS may initiate/organize an aerial survey (by requesting the Navy's assistance pursuant to the memorandum of agreement (MOA) or by other available means) to see if other North Atlantic right whales are in the vicinity. Based on the information provided by the Navy and, if necessary, the outcome of the aerial surveys, NMFS shall determine whether a continued shutdown is appropriate on a case-by-case basis. Though it will be determined on a case-by-case basis after Navy/NMFS discussion of the situation, NMFS anticipates that the shutdown will continue within 14 nmi (26 km) of a live, injured/entangled North Atlantic right whale until the animal dies or has not been seen for at least 3 hours (either by NMFS staff attending the injured animal or Navy personnel monitoring the area around where the animal was last sighted).

5. If the Navy finds a dead North Atlantic right whale floating at sea during an MTE, the Navy shall notify NMFS (pursuant to AFAST Stranding Communication Protocol) 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 behaviors (if alive), and photo or

[4] A MTE is a major training event and includes Composite Training Unit Exercises and Joint Task Force Exercises involving carrier strike groups or expeditionary strike groups

video (if available). Subsequent to the discovery of the dead whale, if the Navy is operating sonar in the area they shall use increased vigilance (in looking for North Atlantic right whales) and all platforms in the area shall report sightings of North Atlantic right whales to NMFS as soon as possible.

Based on the information provided, NMFS may initiate/organize an aerial survey (by requesting the Navy's assistance pursuant to the MOA or by other available means) to see if other North Atlantic right whales are in the vicinity. Based on the information provided by the Navy and, if necessary, the outcome of the aerial surveys, NMFS will determine whether any additional mitigation measures are necessary on a case-by-case basis.

6. In the event, following a USE, that: a) qualified individuals are attempting to herd animals back out to the open ocean and animals are not willing to leave, or b) 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 MFAS/HFAS training activities or explosive detonations, though farther than 14 nmi (26 km) 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.

7. Within 72 hours of NMFS notifying the Navy of the presence of a USE, the Navy shall provide available information to NMFS (per the Communication Protocol) regarding the location, number and types of acoustic/explosive sources, direction and speed of units using MFAS/HFAS, and marine mammal sightings information associated with training activities occurring within 80 nm (148 km) and 72 hours prior to the USE event. Information not initially available regarding the 80 nmi (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.

8. Memorandum of Agreement (MOA) – The Navy and NMFS shall develop a MOA, or other mechanism consistent with federal fiscal law requirements (and all other applicable laws), that will establish a framework whereby the Navy can (and provide the Navy examples of how they can best) assist NMFS with stranding investigations in certain circumstances.

Measures Related to Vessel Transit and North Atlantic Right Whales

The proposed Undersea Warfare Training Range would involve vessel movements from homeports along the eastern U.S. from Connecticut to Florida. The Navy recognizes the potential for interaction (ship strike) with North Atlantic right whales during vessel transits to and from homeports and the proposed Undersea Warfare Training Range, as well as during range activities.

Mid-Atlantic, Offshore of the Eastern United States

For purposes of these measures, the mid-Atlantic is defined broadly to include ports south and east of Block Island Sound southward to South Carolina. The procedure described below would be established as protective measures for Navy vessel transits during North Atlantic right whale migratory seasons near ports located off the western North Atlantic, offshore of the eastern United States. The mitigation measures would apply to all Navy vessel transits, including those vessels that would transit to and from the proposed Undersea Warfare Training Range .

Seasonal migration of North Atlantic right whales is generally described by NMFS as occurring from October 15th through April 30th, when the whales migrate between feeding grounds farther north and calving grounds farther south. The Navy mitigation measures have been established in accordance with rolling dates identified by NMFS consistent with these seasonal patterns. NMFS has identifed ports located in the western Atlantic Ocean, offshore of the eastern United States, where vessel transit during North Atlantic right whale migration is of highest concern for potential ship strike. The ports include the Hampton Roads entrance to the Chesapeake Bay, which includes the concentration of Atlantic Fleet vessels in Norfolk, Virginia. Navy vessels are required to use extreme caution and operate at a slow, safe speed consistent with mission and safety during the months indicated in Table 6-3 and within a 37 km (20 nmi) arc (except as noted) of the specified reference points.

- During the months indicated in Table 1 (below), Navy vessels would practice increased vigilance with respect to avoidance of vessel-whale interactions along the mid-Atlantic coast, including transits to and from any mid-Atlantic ports not specifically identified above.

Table 1. North Atlantic Right Whale Migration Port References

Region	Months	Port Reference Points
South and East of Block Island	September–October and March–April	20 nm seaward of line between 41°4.49N to 71°51.15W and 41°18.58N to 70°50.23W
New York / New Jersey	Sep–Oct and Feb-Apr	40°30.64N to 73°57.76W
Delaware Bay (Philadelphia)	Oct–December and February–March	38°52.13N to 75°1.93W
Chesapeake Bay (Hampton Roads and Baltimore)	November-December and February–April	37°1.11N to 75°57.56W
North Carolina	December–April	34°41.54N to 76°40.20W
South Carolina	October–April	33°11.84N to 79°8.99W 32°43.39N to 79°48.72W

• All surface(d) units transiting within 56 km (30 nmi) of the coast in the mid-Atlantic would ensure at least two lookouts are posted, including at least one lookout that has completed required MSAT training.

• Navy vessels would not knowingly approach any whale head on and would maneuver to keep at least 457 m (1,500 ft) away from any observed whale, consistent with vessel safety.

Additionally, all Navy vessels assume a slow, safe speed (on the range and in transit) that is dependent upon the situation, would allow the ship to maneuver around any navigational hazards (including marine mammals), and relies upon the judgment and experience of the vessel's captain. Navy vessels will additionally abide by the USCG Navigation Rules (U.S. Coast Guard 2008b) while traveling to and using the Undersea Warfare Training Range. Vessels may operate in a manner outside the Navigation Rules when the training exercise requires realistic combat maneuvers.

Southeast Atlantic, Offshore of the Eastern United States

For purposes of these measures, the southeast encompasses sea space from Charleston, South Carolina, southward to Sebastian Inlet, Florida, and from the coast seaward to 148 km (80 nmi) from shore. The mitigation measures described in this section were developed specifically to protect the North Atlantic right whale during its calving season (typically from December 1st through March 31st). During this period, North Atlantic right whales give birth and nurse their calves in and around federally designated critical habitat off the coast of Georgia and Florida.

This critical habitat is the area from 31-15N to 30-15N extending from the coast out to 28 km (15 nmi), and the area from 28-00N to 30-15N from the coast out to 9 km (5 nmi). All mitigation measures that apply to the critical habitat also apply to an associated area of concern which extends 9 km (5 nmi) seaward of the designated critical habitat boundaries.

Prior to transiting or training in the critical habitat or associated area of concern, ships would contact Fleet Area Control and Surveillance Facility, Jacksonville, to obtain latest whale sighting and other information needed to make informed decisions regarding safe speed and path of intended movement. Subs would contact Commander, Submarine Group Ten for similar information.

Specific mitigation measures related to activities occurring within the critical habitat or associated area of concern during the calving season include the following:

• When transiting within the critical habitat or associated area of concern, vessels would exercise extreme caution and proceed at a slow safe speed. The speed would be the slowest safe speed that is consistent with mission, training, and operations.

• Speed reductions (adjustments) are required when a whale is sighted by a vessel or when the vessel is within 9 km (5 nmi) of a reported sighting less than 12 hours old.

• Additionally, circumstances could arise where, in order to avoid North Atlantic right whale(s), speed reductions could mean vessel must reduce speed to a minimum at which it can safely keep on course or vessels could come to an all stop.

• Vessels would avoid head-on approach to North Atlantic right whale(s) and would maneuver to maintain at least 457 m (1,500 ft) of separation from any observed whale if deemed safe to do so. These requirements would not apply if a vessel's safety is threatened, such as when change of course would create an imminent and serious threat to person, vessel, or aircraft, and to the extent vessels are restricted in the ability to maneuver.

• Ships would not transit through the critical habitat or associated area of concern in a North-South direction.

• Ship, surfaced subs, and aircraft would report any whale sightings to Fleet Area Control and Surveillance Facility, Jacksonville, by most convenient and fastest means. Sighting report would include the time, latitude/longitude, direction of movement and number and description of whale(s) (i.e., adult/calf).

Measures Related to Cable Installation at Sea

The following measures would be taken during cable installation to ensure that effects to marine resources, both biological and physical, are avoided to the maximum extent possible:

• Lookouts would be posted on all vessels participating in the cable installation processes, to observe for marine mammals and sea turtles. Lookouts would advise the Captain to the presence of a marine mammal or sea turtle, in order to prevent entanglement or ship strike.

• Lookouts would observe for *Sargassum* mats, and inform the Captain, to facilitate avoiding the mats to the maximum extent possible.

• As proposed, cable installation would be suspended during the North Atlantic right whale calving season (from November 15 through April 15).

• A bottom mapping effort would be completed prior to commencement of cable installation. This bottom mapping effort would utilize methodologies such as multi-beam sonar, photography and videography of bottom features, and biological and geological sampling. Information gained from this mapping effort would allow for the identification of important biological and physical features, such as biogenic reef formations and shipwrecks. Knowledge of the presence of these features would allow for their avoidance to the maximum extent practicable.

1.8.2.2 Scope of the MMPA Regulations for the USWTR

The Permits Division has not yet issued regulations for U.S. Navy training activities that would occur in the Undersea Warfare Training Range and is not scheduled to issue those regulations until 2014 (when the U.S. Navy plans to begin training on the range).

2.0 Approach to the Assessment

2.1. Overview of NMFS' Assessment Framework

Section 7(a)(2) of the Endangered Species Act of 1973, as amended (16 U.S.C. 1536(a)(2)), requires Federal agencies, in consultation with and with the assistance of the National Marine Fisheries Service and U.S. Fish and Wildlife Service, to insure that any action they authorize, fund, or carry out is not likely to jeopardize the continued existence of endangered species or threatened species or result in the destruction or adverse modification of critical habitat that has been designated for those species. When the National Marine Fisheries Service consults with Federal agencies to help them comply with this requirement of law, we first assess the direct and indirect effects of the proposed federal action to determine whether the proposal is likely to (a) appreciably increase a species' extinction probability (or reduce their probability of being conserved or recovered) or (b) appreciably reduce the conservation value of critical habitat that has been designated for one or more of those species. If we conclude that one of these outcomes is likely, we work with the Federal agency, applicant, or both, to develop alternatives that avoid this likelihood.

NMFS uses a series of sequential analyses to assess the effects of federal actions on endangered and threatened species and designated critical habitat. The first step of our analyses identify those physical, chemical, or biotic aspects of proposed actions that are likely to have individual, interactive, or cumulative direct and indirect effect on the environment (we use the term "potential stressors" for these aspects of an action). As part of this step, we identify the spatial extent of any potential stressors and recognize that the spatial extent of those stressors may change with time (the spatial extent of these stressors is the "action area" for a consultation).

To begin the second step of our analyses, we determine whether endangered species, threatened species, or designated critical habitat are likely to occur in the same space and at the same time as these potential stressors. If we conclude that such co-occurrence is likely, we then try to estimate the nature of that co-occurrence (these represent our *exposure analyses*). In this step of our analyses, we try to identify the number, age (or life stage), and gender of the individuals that are likely to be exposed to an Action's effects and the populations or subpopulations those individuals represent.

Once we identify which listed resources (endangered and threatened species and designated critical habitat) are likely to be exposed to potential stressors associated with an action and the nature of that exposure, in the third step of our analyses we examine the scientific and commercial data available[5] to determine whether and how those listed resources are likely to respond given their exposure (these represent our *response analyses*). The final steps of our analyses — establishing the risks those responses pose to listed resources — are different for listed species and designated critical habitat (these represent our *risk analyses*).

RISK ANALYSES 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 (see Stearns 1992). 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

[5] Although section 7(a)(2) of the Endangered Species Act of 1973, as amended, requires us to use the best scientific and commercial data available, at this stage of our analyses, we consider all lines of evidence. We summarize how we identify the "best scientific and commercial data available" in a subsequent subsection titled "Evidence Available for the Consultation"

consequences on the viability of the populations those individuals represent or the species those populations comprise (for example, see Anderson 2000, Mills and Beatty 1979, Stearns 1992). 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.

When we consider the potential effects of actions on populations of endangered or threatened species or on the species themselves, that consideration is informed by our understanding of the patterns, processes, and causal agents that are known to have resulted in the extinction of numerous populations and species in the past. Several studies of population and species extinctions reveal similar patterns those entities follow on their path to extinction and as they recover from extinction (for example, see Channell and Lomolino 2000; Fagan *et al*. 1999, 2001; Fagan and Holmes 2006; Gaston 1994, Lomolino and Channell 1995, 1998; McKinney 1997, O'Grady *et al*. 2004). Specifically, most populations or species appear to experience similar patterns of instability, decline, collapse (primarily range contraction or erosion), and small population dynamics before they become extinct; we consider those patterns qualitatively and quantitatively (when data are available and suitable for formal analysis) when we assess the status of endangered and threatened species and the potential effects of proposed actions on that status.

RISK ANALYSES 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[6]. 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*

[6] 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.

natural environment, we ask if primary or secondary constituent elements included in the designation (if there are any) or physical, chemical, 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 constituent elements of designated critical habitat; and (f) the temporal distribution of constituent elements of designated critical habitat.

If primary or secondary 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.

If the quantity, quality, or availability of the primary or secondary 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 ecologyical 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 ask 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.

A NOTE ON "SIGNIFICANCE." In biological opinions, we distinguish among different kinds of "significance" (as that term is commonly used for NEPA analyses). First, we focus on potential physical, chemical, or biotic stressors that are "significant" in the sense of "salient" in the sense of being distinct from ambient or background. We then ask if

(1) (a) exposing individuals to those potential stressors is likely to represent a "significant" adverse experience in the life of individuals that have been exposed; (b) exposing individuals to those potential stressors is likely to cause the individuals to experience "significant" physical, chemical, or biotic responses; and (c) any "significant" physical, chemical, or biotic response are likely to have "significant" consequence for the fitness of the individual animal; and

(2) (a) exposing the physical, chemical, or biotic phenomena that we identified 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 (b) 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, Johnson 1999, Royall 2004).

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 is 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.

2.2. Application of this Approach in this Consultation

The military readiness activities the U.S. Navy proposes to undertake in the Northeast Operating Area, the Virginia Capes Range Complex, the Cherry Point Range Complex, the Jacksonville Range Complex, and King's Bay, Georgia, are likely to produce the following stressors:

1. the risk of collisions with vessels involved in the U.S. Navy's proposed training activities and the proposed Transit Protection System at King's Bay, Georgia;
2. underwater detonations associated with the U.S. Navy's proposed training activities;
3. expended ordnance associated with the U.S. Navy's proposed training activities;
4. disturbance associated with the movement of Navy vessels and aircraft involved in the training activities the U.S. Navy plans to conduct;
5. chemicals in explosive charges and other ordnance employed during training activities.
6. mid- and high-frequency active sonar employed during the Atlantic Fleet Active Sonar Training activities that are interrelated with the proposed actions;
7. the explosive source associated with the Improved Extended Echo Ranging (IEER) System that are also employed during the Atlantic Fleet Active Sonar Training activities that are interrelated with the proposed actions; and
8. parachutes associated with some of the sonobuoys employed during the Atlantic Fleet Active Sonar Training activities that are interrelated with the proposed actions

Our section 7 consultation considered the number of endangered or threatened marine animals (that is, those marine animals that are under the jurisdiction of the National Marine Fisheries Service) that might be exposed to these different stressors, the nature of those exposures, the animal's probable responses upon being exposed, and the risks those responses might pose to individual animals, the populations those individuals represent, and the species those populations comprise.

2.2.1. Exposure Analyses.

As discussed in the introduction to this section of this Opinion, exposure analyses are designed to identify the listed resources that are likely to co-occur with these effects in space and time and the nature of that co-occurrence. Our exposure analyses are designed to identify the number, age (or life stage), and gender of the individuals that are likely to be exposed to an Action's effects and the populations or subpopulations those individuals represent.

For our exposure analyses, NMFS relied solely on the results of models the U.S. Navy conducted for their NEPA compliance documents for the training activities considered in this Opinion (U.S. Navy 2008a, 2008b, 2008c). However, before we used the results, we critically evaluated the exposure models the U.S. Navy and Permits Division used to estimate the number of instances in which marine mammals and sea turtles might be exposed to those activities. Based on that evaluation, we concluded that those exposure models would tend to overestimate the number of exposure events because (1) the U.S. Navy's models assume that estimates of the mean density of marine mammals per square kilometer developed for a season or year would also represent the mean density of those species at time intervals shorter than a season or year; that assumption would tend to overestimate the number of marine mammals that are likely to be exposed to Navy training activities because we would expect to encounter a greater number of marine mammals if we remained at a location for a year than we would encounter if we only remained in the same location for only three hours, three days, or three weeks. As the duration of an exercise or other training activity becomes shorter (for example, moving from a major training exercise to a unit-level training exercise), the U.S. Navy's exposure models would increasingly overestimate the number of marine mammals we would actually expect to occur in a particular area; (2) the U.S. Navy's models assume that the density of marine mammals is effectively constant throughout at-sea Operating Areas rather than assuming that they are patchily distributed (that is, they exist as social groups of various sizes) throughout the action area; that assumption would also tend to overestimate the number of marine mammals that might be exposed to a training activity. Despite the limitations of the U.S. Navy's models, by relying on models that tend to overestimate the number of exposure events associated with the training activities the U.S. Navy proposes to conduct along the Atlantic Coast of the United States, we are confident that we continue to provide the benefit of uncertainty to endangered and threatened species.

2.2.2. Response Analyses

As discussed in the introduction to this section of these Opinions, once we identified which listed resources were likely to be exposed to active sonar, underwater detonations, and disturbance associated with the proposed training activities and the nature of that exposure, we examined the scientific and commercial data available to determine whether and how those listed resources are likely to respond given their exposure (Figure 5). Prior to this consultation, we made several major changes to the conceptual model that forms the foundation for our response analyses. First, we constructed our revised model on a model of animal behavior and behavioral decision-making, which incorporates the cognitive processes involved in behavioral decisions; earlier versions of this model ignored critical components of animal behavior and behavioral decision-making. As a result, our revised model assumes that Navy training activities primarily affect endangered and threatened species by changing their behavior, although we continue to recognize the risks of physical trauma and noise-induced losses in hearing sensitivity (threshold shift). Second, we expanded our conception of "hearing" that includes cognitive processing of auditory cues, rather than a focus solely on the mechanical processes of the ear and auditory nerve. Third, our revised model incorporates the primary mechanisms by which behavioral responses affect the longevity and reproductive success of animals: changing an animal's energy budget, changing an animal's time budget (which is related to changes in an animal's energy budget), forcing animals to make life history trade-offs (for example, engaging in evasive behavior such as deep dives that involve short-term risks while promoting long-term survival), or changes in social interactions among groups of animals (for example, interactions between a cow and her calf).

Like our earlier conceptual models (presented in Southall *et al* 2008), this conceptual model begins with acoustic stimuli that we focus on in an assessment (Box 1 in Figure 5). In this case, we treat the active sonar and any pressure waves or sound fields associated with underwater detonations as separate focal stimuli. The preceding section of our *Approach* described how we estimated the number of animals that are likely to be exposed to those acoustic stimuli associated with the proposed training activities and the nature of that exposure.

The potential stressors associated with the training exercises the U.S. Navy proposes to conduct along the Atlantic Coast of the United States consist of two classes: *processive stressors*, which require high-level cognitive processing of sensory information, and *systemic stressors*, which usually elicit direct physical or physiological responses and, therefore, do not require high-level cognitive processing of sensory information (Anisman and Merali 1999, de kloet 2003, Herman and Cullinan 1997). Disturbance from surface vessels and active sonar would be examples of processive stressors while ship strikes and pressure waves associated with underwater detonations would be examples of systemic stressors (the sound field produced by an underwater detonation would be a systemic stressor close to the explosion and a processive stressor further away). As a result, exposures resulting from the proposed training exercises are likely to result in two general classes of responses:

1. responses that are influenced by an animal's assessment of whether a potential stressor poses a threat or risk (see Figure 5: Behavioral Response).

2. responses that are not influenced by the animal's assessment of whether a potential stressor poses a threat or risk (see Figure 5: Physical Damage).

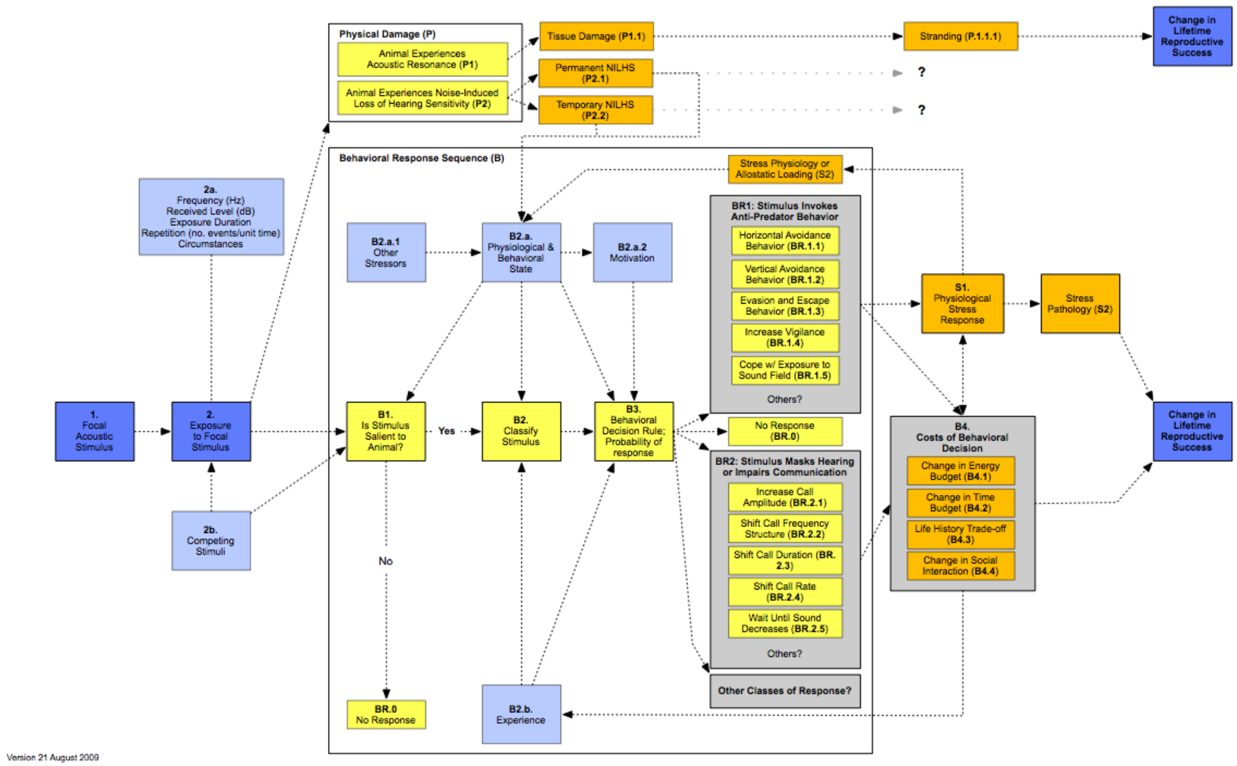

Figure 5. Conceptual model of the potential responses of endangered and threatened species upon being exposed to active sonar and the pathways by which those responses might affect the fitness of individual animals that have been exposed. See text contained in "Application of this Approach" and "Response Analyses" for an explanation and supporting literature.

Unlike our earlier conceptual model, our revised model explicitly acknowledges the existence of other acoustic and non-acoustic stimuli in an animal's environment that might diminish the focal stimulus' salience (the line connecting Box 2b. to Box 2) or that might compete for the animal's finite attentional resources, which would affect the salience of the focal stimulus as perceived by the animal (the line connecting Box 2b to Box B7). Absent information to the contrary, our assessment assumes the focal stimulus remains salient regardless of competing stimuli and the limited attentional resources of animals. By extension, we assume that any behavioral change we might observe in an animal would have been caused by the focal stimulus rather than competing stimuli.

If we conclude (or if we assume) that an acoustic stimulus, such as mid-frequency active sonar, was salient, we would then ask how an animal might classify the stimulus as a cue about its environment (Box B2) because an animal's response to a stimulus in its environment will depend upon whether and how the animal converts the stimulus into some information about its environment (Blumstein and Bouskila 1996[7], Yost 2007). For example, if an animal classifies a stimulus as a "predatory cue" that classification will invoke a suite of candidate physical, physiological, or behavioral responses that are appropriate to being confronted by a predator (this would occur regardless of whether a predator is, in fact, present).

Our revised conceptual model departs from our earlier model and models advanced by the U.S. Navy and others by adopting a more expansive concept of "hearing". Other conceptions of the sensory modality that we call "hearing" have focused on the the mechanical processes associated with structures in the ear that transduce sound pressure waves into vibrations and vibrations to electro-chemical impulses. That conception of hearing resulted in assessments that focus exclusively on active sonar while discounting other acoustic stimuli associated with U.S. Navy training activities that marine animals might also perceive as relevant. That conception of hearing also led to an almost singular focus on the intensity of the sound ─ its received level (in decibels) ─ as an assessment metric and noise-induced hearing loss as an assessment endpoint. Among other considerations, that focus fails to recognize that animals will tend to treat sounds as environmental cues (a stimulus that provides information about an animal's environment); that animals have to decide which environmental cues they will focus on given that their ability to process those cues is limited; that animals can distinguish not only received levels of a sound, they also perceive their distance from the source of the sound; that both received levels and the spectral qualities of sounds degrade over distance so an animal that receives the signal at some distance from the source would not receive the same signal as an animal that is close to the sound's source; that animals are

[7] See Blumstein and Bouskila (1996) for more extensive reviews of the literature on how animals process and filter sensory information, which affects the subjective salience of sensory stimuli. See Crick (1984), Dukas (2002), Dukas and Real (19993), and Roitblat (1987) for more extensitve reviews of the literature on attentional processes and the consequences of limited attentional resources.

more likely to devote attentional resources to those environmental cues that are proximate than to cues that are distant.

Our revised conceptual model expands the conception of "hearing" to include a mechanical-cognitive-perceptual processes. That is, it includes the mental processes an animal employs when it analyzes acoustic impulses (see Aikin 1990, Bregman 1990, Blumstein and Bouskila 1996, Hudspeth 1997, Pickles 1982, Yost 2007), which includes the processes animals employ to integrate and segregate sounds and auditory streams and the circumstances under which they are likely to devote attentional resources to an acoustic stimulus. As a result of this shift in focus, we have to consider more than the received level of a particular low- or mid-frequency wave form and its effects on the sensitivity of an animal's ear structure, we also have to distinguish between different auditory scenes; for example, animals will distinguish between sounds from a source that is moving away versus a sound produced by a source that is approaching them, sounds from multiple sources that are all approaching, and sounds from multiple sources that appear to be moving at random, etc.

Animals would then combine their perception of the acoustic stimulus with their assessment of the auditory scene (which include other acoustic stimuli), their awareness of their behavioral state, physiological state, reproductive condition, and social circumstances to assess whether the acoustic stimulus poses a risk and the degree of risk it might pose, whether it is impairing their ability to communicate with conspecifics, whether it is impairing their ability to detect predators or prey, etc. We assume that animals would classify an acoustic source differently if the source is moving towards the animal's current position (or projected position), moving away from the animal's position, moving tangential to the animal's position, if the source is stationary, or if there are multiple acoustic sources in the animal's auditory field.

This process of "classifying a stimulus" (Box B2) lends meaning to a stimulus and places the animal in a position to decide whether and how to respond to the stimulus (Blumstein and Bouskila 1996, Bottledooren *et al*. 2008). How an animal classifies a stimulus will determine the set of candidate responses that are appropriate. That is, we assume that animals that classified a stimulus as a"predatory cue" would invoke candidate responses that consisted of antipredator behavior rather than foraging behavior (Bejder *et al*. 2009, Blumstein and Bouskila 1996). We then assume that animals apply one or more behavioral decision rules to the set of candidate responses that are appropriate to the acoustic stimulus as it has been classified (Box B3). Our use of the term "behavioral decision rule" follows Blumstein and Bouskila (1996), Dill (1987), McFarland (1987), and Lima and Dill (1990) and is synonymous with the term "behavioral policy" of McNamara and Houston (1986): the process an animal applies to determine which specific behavior it will select from the set of behaviors that are appropriate to the auditory scene, given its physiological and behavioral state when exposed and its experience. Because we would never know the behavioral policy of an individual, free- ranging animal, we treat this policy as a probability distribution function that matches the vector of candidate behavioral responses.

Once an animal selects a behavioral response from a set of candidate behaviors, we would assume that any change in behavior would represent a shift from an optimal behavioral state (or behavioral act) to a sub-optimal behavioral state (or behavioral act) and that the selection of the sub-optimal behavioral state or act would be accompanied by *canonical costs*, which are reductions in the animal's expected future reproductive success that would occur when an animal engages in suboptimal behavioral acts (McNamara and Houston 1986). Specifically, canonical costs represent a reduction in current and expected future reproductive success (which integrates survival and longevity with current and future reproductive success) that would occur when an animal engages in a sub-optimal rather than an optimal sequence of behavioral acts; given the pre-existing physiological state of the animal in a finite time interval (Barnard and Hurst 1996, Houston 1993, McFarland and Sibly 1975, McNamara 1993, McNamara and Houston 1982, 1986, 1996; Nonacs 2001). Canonical costs would generally result from changes in animals' energy budgets (McEwen and Wingfield 2003, Moberg 2000; Romero 2004, Sapolsky 1990, 1997), time budgets (Frid and Dill 2002, Sutherland 1996), life history trade-offs (Cole 1954, Stearns 1992), changes in social interactions (Sutherland 1996), or combinations of these phenomena (see Box B4 of Figure 5). We assume that an animal would not incur a canonical cost if they adopted an optimal behavioral sequence (see McNamara and Houston 1986 for further treatment and discussion).

This conceptual model does not require us to assume that animals exist in pristine environments; in those circumstances in which animals are regularly or chronically confronted with stress regimes that animals would adapt by engaging in sub-optimal behavior, we would assume that a change in behavior that resulted from exposure to a particular stressor or stress regime would either contribute to their sub-optimal behavior or would force them to engage in behavior that is even further from optimal.

We used empirical Bayesian analysis to estimate the probability of one or more of the proximate responses identified in Figure 5 given an exposure event from the data that were available. Bayes rule (also called Bayes' theorem) calculates the probability of an event given prior knowledge of the event's probability using the equation

$$\text{Prob}(R_i|D) = [\Pr(D|R_i) \times \Pr(R_i)]/\Sigma[\Pr(D|R_j) \times \Pr(R_j)]$$

Where *R* represents the set of mutually exclusive and exhaustive physical, physiological, and behavioral responses to an exposure with probabilities, Pr(Ri), Pr(Rj) represents alternatives to that particular response, and *D* represents the data on responses. In this formulation, Pr(Ri) in the numerator, represents the prior probability of a response which we derived from (1) the number of reports in the literature, that is, the number of papers that reported a particular response (here we distinguished between the number of reports for all cetaceans, the number of reports for all odonotocetes, and the number of reports for all mysticetes) and (2) an uninformed prior, which assumed that all responses that had non-zero values were equally probable.

To apply this procedure to our response analyses for active sonar exposure, we formed the set of potential responses using the "proximate responses" identified in Figure 5 (see Table 6). Then we identified the number of instances in which animals were reported to have exhibited one or more of those proximate responses based on published studies or studies available as gray literature. For example, Nowacek *et al* (2004) reported one instance in which North Atlantic right whales exposed to alarm stimuli did not repond to the stimulus and several instances in which right whales exhibited "disturbance" responses. We coded these two responses (no response and disturbance response) separately.

For the response analyses we include in these Opinions, which are on the Letters of Authorization the Permits Division proposes to issue, we multiply our exposure estimates (which provided us with the number of instances of exposure) by these posterior probabilities (which identify the probability of a particular response given an exposure) to estimate the number of animals in the exposed population that might respond with particular responses. If, for the purposes of illustration, we assumed that 100 fin whales might be exposed to active sonar and further assumed that their probability of no responding, avoidance responses, and evasive response was 0.5414, 0.0650, and 0.0440, respectively, we would assume that 54 of the 100 fin whales would not respond to the exposure, 6 might respond by avoiding the sound field, and 4 might respond by evading the sound field.

Table 6. Grouping of proximate responses (identified in Figure 3) into categories for response analyses

	Proximate Response	Grouping for Bayesian Analyses
1	No response	No Response
2	Acoustic resonance	Physical Trauma
3	Noise-induced hearing loss (P)	Not used for formal analyses
4	Noise-induced hearing loss (T)	Not used for formal analyses
5	Reduced auditory field (reduced active space)	Not used for formal analyses
6	Signal masking	Not used for formal analyses
7	Increase call amplitude of vocalizations	Vocal Adjustments
8	Shift frequency structure of vocalizations	
9	Shift call duration of vocalizations	
10	Shift call rate of vocalizations	
11	Shift timing of vocalizations	
12	Physiological stress	Not used for formal analyses
13	Avoid sound field	Avoidance Response
14	Avoid received levels in sound field	
15	Abandon area of exercise	Evasive Response
16	Increase vigilance	Not used for formal analyses
17	Exhibit "disturbance" behavior	Behavioral Disturbance
18	Continue current behavior (coping)	No Response
19	Unspecified behavioral responses (adverse)	Unspecified behavioral responses (adverse)
20	Unspecified behavioral responses (not adverse)	Unspecified behavioral responses (not adverse)

21	Behaviors that cannot be classified	Not used for formal analyses

To estimate the number of animals that might be "taken" in any Opinions we prepare on any Letters of Authorization the Permits Division issues, we would classify the responses as one or more form of "take" (for example, we would distinguish between *avoidance*, or an animal that shifts its position before a perceived predatory stimulus has an opportunity to attack, and *evasion*, or an escape response to a perceived attack) and use the method we described in the preceding paragraph to estimate the amount of "take".

2.2.3 Risk Analyses

As discussed in the *Introduction* to this section of the Opinion, the final steps of our analyses — establishing the risks those responses pose to endangered and threatened species or designated critical habitat — 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 (see Stearns 1992). If we conclude that listed plants or animals are *not* likely to experience reductions in their fitness, we would conclude our assessment.

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 determine if the number of individuals that experience reduced fitness (or the magnitude of any reductions) is 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 probability of becoming demographically, ecologically, or genetically extinct in 10, 25, 50, or 100 years). 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.

Our risk analyses conclude by determining whether changes in the viability of one or more population is or is not likely to be sufficient to reduce the viability of the species (measured using probability of demographic, ecological, or genetic extinction in 10, 25, 50, or 100 years) those populations comprise. For these analyses, we combine our knowledge of the patterns that accompanied the decline, collapse, or extinction of populations and species that are known to have declined, collapsed, or become extinct in the past as well as a suite of population viability models.

When we conduct these analyses, our assessment is designed to establish that a decline, collapse, or extinction of an endangered or threatened species is not likely; we do not conduct these analyses to establish that such an outcome is likely. In this step of our analyses, we use the species' status (established in the *Status of the Species* section of these Opinions) as our point of reference.

2.3. 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 sound and its effects 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 for example, Abgrail *et al*. 2008, Bowles *et al.* 1994; Croll *et al.* 1999, 2001; Frankel and Clark 1998; Gisiner 1998, McCauley and Cato 2001; NRC 1994 1996, 2000, 2003, 2005; Norris 1994; Reeves 1992, Richardson *et al.* 1995, Southall *et al*. 2007, Tyack 2000, 2007; Wright *et al.* 2007).

To comply with our obligation to use the best scientific and commercial data available, we conducted additional searches to identify information that has become available since we issued the programmatic biological opinion on the training operations conducted in the Virginia Capes, Cherry Point and Jacksonville Range Complexes and on the Permits Division's 2009-2014 MMPA regulations and the annual biological opinion on these activities and the Permits Division's associated Letters of Authoriation from 2009-2010 and 2010-2011. The Navy has provided NMFS with reports on the major training exercises that were conducted in the Action Area of our biological opinions on the training operations in the three range complexes and the results of their monitoring studies associated with those training activities.

Despite the information that has become available since our earlier opinions, this assessment continued to involve a large amount of uncertainty about the basic hearing capabilities of marine mammals; how marine mammals 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 marine mammals;

the mechanisms by which human-generated sounds affect the behavior and physiology (including the non-auditory physiology) of marine mammals, and the circumstances that are likely to produce outcomes that have adverse consequences for individual marine mammals and marine mammal populations (see NRC 2000 for further discussion of these unknowns).

2.4. Treatment of "Cumulative Impacts" (in the sense of NEPA)

Several organizations have argued that several of our previous biological opinions on the U.S. Navy's use of active sonar failed to consider the "cumulative impact" (in the NEPA sense of the term) of active sonar on the ocean environment and its organisms, particularly endangered and threatened species and critical habitat that has been designated for them (for example, see NRDC 2007 and Ocean Mammal Institute 2007). In each instance, we have had to explain how biological opinions consider "cumulative impacts" (in the NEPA sense of the term).

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.

2.5. A Brief Background on Sound

Sound is a wave of pressure variations propagating through a medium (for the sonar considered in this Opinion, the medium is marine water). Pressure variations are created by compressing and relaxing the medium. Sound measurements can be expressed in two forms: *intensity* and *pressure*. Acoustic intensity is the average rate of energy transmitted through a unit area in a specified direction and is expressed in watts per square meter (W/m^2). Acoustic intensity is rarely measured directly, it is derived from ratios of *pressures*; the standard reference pressure for underwater sound is 1 microPascal (μPa); for airborne sound, the standard reference pressure is 20 μPa (Richardson et al 1995a).

Acousticians have adopted a logarithmic scale for sound intensities, which is denoted in decibels (dB). Decibel measurements represent the ratio between a measured pressure value and a reference pressure value (in this case 1 μPa or, for airborne sound, 20 μPa.). The logarithmic nature of the scale means that each 10 dB increase is a ten-fold increase in power (e.g., 20 dB is a 100-fold increase, 30 dB is a 1,000-fold increase). The term "sound pressure level" implies a decibel measure and a reference pressure that is used as the denominator of the ratio. Throughout this Opinion, we use 1 microPascal (denoted re: 1μPa) as a standard reference pressure unless noted otherwise.

It is important to note that decibels underwater and decibels in air are not the same and cannot be directly compared. Because of the different densities of air and water and the different decibel standards in water and air, a sound with the same intensity (i.e., power) in air and in water would be approximately 63 dB quieter in air.

Sound frequency is measured in cycles per second, or Hertz (abbreviated Hz), and is analogous to musical pitch; high-pitched sounds contain high frequencies and low-pitched sounds contain low frequencies. Natural sounds in the ocean span a huge range of frequencies: from earthquake noise at 5 Hz to harbor porpoise clicks at 150,000 Hz. These sounds are so low or so high in pitch that humans cannot even hear them; acousticians call these infrasonic and ultrasonic sounds, respectively. A single sound may be made up of many different frequencies together. Sounds made up of only a small range of frequencies are called "narrowband", and sounds with a broad range of frequencies are called "broadband"; airguns are an example of a broadband sound source and sonars are an example of a narrowband sound source.

When considering the influence of various kinds of noise on the marine environment, it is necessary to understand that different kinds of marine life are sensitive to different frequencies of sound. Most dolphins, for instance, have excellent hearing at very high frequencies between 10,000 and 100,000 Hz. Their sensitivity at lower frequencies below 1000 Hz; however, is quite poor. On the other hand, the hearing sensitivity of most sea turtles appears to be best at frequencies between about 200 Hz and 700 Hz. As a result, sea turtles might be expected to suffer more harmful effects from low frequency noise than would dolphins.

When sound travels away from its source, its loudness decreases as the distance traveled by the sound increases. Thus, the loudness of a sound at its source is higher than the loudness of that same sound a kilometer distant. Acousticians often refer to the loudness of a sound at its source as the *source level* and the loudness of sound elsewhere as the *received level*. For example, a humpback whale 3 kilometers from an airgun that has a source level of 230 dB may only be exposed to sound that is 160 dB loud. As a result, it is important not to confuse source levels and received levels when discussing the loudness of sound in the ocean.

As sound moves away from a source, its propagation in water is influenced by various physical characteristics, including water temperature, depth, salinity, and surface and bottom properties that cause refraction, reflection, absorption, and scattering of sound waves. Oceans are not homogeneous and the contribution of each of these individual factors is extremely complex and interrelated. The physical characteristics that determine the sound's speed through the water will change with depth, season, geographic location, and with time of day (as a result, in actual sonar operations, crews will measure oceanic conditions, such as sea water temperature and depth, to calibrate models that determine the path the sonar signal will take as it travels through the ocean and how strong the sound will be at given range along a particular transmission path).

Sound tends to follow many paths through the ocean, so that a listener may hear multiple, delayed copies of transmitted signals (Richardson et al 1995a). Echoes are a familiar example of this phenomenon in air. In order to determine what the paths of sound transmission are, one rule is to seek paths that deliver the sound to the receiver the fastest. If the speed of sound were constant throughout the ocean, acoustic rays would consist of straight-line segments, with reflections off the surface and the bottom. However, because the speed of sound varies in the ocean, most acoustic rays do not follow a straight path.

Sound speed in seawater is generally about 1,500 meters per second (5,000 feet per second) although this speed varies with water density, which is affected by water temperature, salinity (the amount of salt in the water), and depth (pressure). The speed of sound increases as temperature and depth (pressure), and to a lesser extent, salinity, increase. The variation of sound speed with depth of the water is generally presented by a "sound speed profile," which varies with geographic latitude, season, and time of day.

As sound travels through the ocean, the intensity associated with the wave front diminishes, or attenuates. In shallow waters of coastal regions and on continental shelves, sound speed profiles become influenced by surface heating and cooling, salinity changes, and water currents. As a result, these profiles tend to be irregular and unpredictable, and contain numerous gradients that last over short time and space scales. This decrease in intensity is referred to as propagation loss, also commonly called transmission loss. In general, in a homogeneous lossless medium, sound intensity decreases as the square of the range due to simple spherical spreading. In other words, a source level of 235 dB will have decreased in intensity to a received level of 175 dB after about 914 meters (1,000 yards).

2.6. Action Area

The action area for this biological opinion encompasses the marine and coastal waters along the Atlantic Coast of the United States (see Figures 1, 2, and 3). Specifically, the action area includes waters within and adjacent to the Boston Complex Operating Area, the Narragansett Operating Area, Atlantic City Operating Area, Virginia Capes operating Areas, Cherry Point Operating Area, Jacksonville-Charleston Operating Areas, Key West Operating Area, Pensacola-Panama City Operating Area, New Orleans operating Area, and Corpus Christi Operating Area.

We assume that any activities that are likely to occur landward of the mean higher high water line — including activities that may affect threatened or endangered species of sea turtle landward of the mean higher high water line are addressed in separate section 7 consultations with the U.S. Fish and Wildlife Service.

3.0 Status of Listed Resources

NMFS has determined that the following species and critical habitat designations may occur in this action area for the proposed training activities in the Northeast Operating Areas, Virginia Capes Range Complex, Cherry Point Range Complex, and Jacksonville Range Complex:

Blue whale	*Balaenoptera musculus*	Endangered
Fin whale	*Balaenoptera physalus*	Endangered
Humpback whale	*Megaptera novaeangliae*	Endangered
North Atlantic right whale	*Eubalaena glacialis*	Endangered
Sei whale	*Balaenoptera borealis*	Endangered
Sperm whale	*Physeter macrocephalus*	Endangered
Green sea turtle	*Chelonia mydas*	Threatened
Hawksbill sea turtle	*Eretmochelys imbricata*	Endangered
Kemp's ridley sea turtle	*Lepidochelys kempii*	Endangered
Leatherback sea turtle	*Dermochelys coriacea*	Endangered
Loggerhead sea turtle	*Caretta caretta*	Threatened
Loggerhead sea turtle (Northwest Atlantic)	*Caretta caretta*	Threatened [8]
Atlantic salmon (Gulf of Maine)	*Salmo salar*	Endangered
Smalltooth sawfish	*Pristis pectinata*	Endangered
Shortnose sturgeon	*Acipenser brevirostrum*	Endangered
Atlantic sturgeon	*Acipenser oxyrinchus oxyrinchus*	Endangered/Threatened[9]

Critical habitat has also been designated for the northern right whale in the Atlantic Ocean in Cape Cod Bay, Great South Channel, and off Georgia and Florida (50 CFR 226.203). Critical habitat for green sea turtles has been designated on Culebra Island, Puerto Rico (50 CFR 226.208), for hawksbill sea turtles on Mona and Monita Islands, Puerto Rico (50 CFR 226.209), and for leatherback sea turtles on Sandy Point on Saint Croix in the U.S. Virgin Islands (50 CFR 226.207).

3.1 Species Not Considered Further in these Opinions

[8] On March 15, 2010 (75 FR 12598), NMFS issued a proposed rule that determined that globally loggerhead sea turtles comprise at least nine distinct population segments (DPSs). Two of these DPSs were proposed as threatened species and the remaining seven DPSs were proposed as endangered.

[9] On October 6, 2010 (75 FR 61872), NMFS issued a proposed rule that determined that Atlantic sturgeon are comprised of five DPSs and warranted consideration for listing. Four of these DPSs were proposed as endangered species and one DPS was proposed as a threatened species.

As described in the *Approach to the Assessment section* of these Opinions, NMFS uses two criteria to identify those endangered or threatened species or critical habitat that are not likely to be adversely affected by the proposed training and operations in the U.S. Navy Range Complexes along the along the Atlantic Coast of the United States and in the Gulf of Mexico from June 2009 to June 2014. The first criterion was *exposure* or some reasonable expectation of a co-occurrence betweeon one or more potential stressor associated with the U.S. Navy's 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 U.S. Navy's 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*: species that may be exposed to sound transmissions from active sonar, for example, but are likely to be unaffected by the sonar (at sound pressure levels they are likely to be exposed to) are also not likely to be adversely affected by the sonar. We applied these criteria to the species listed at the beginning of this section; this subsection summarizes the results of those evaluations.

Atlantic salmon (Gulf of Maine). Atlantic salmon are an anadromous species: spawning and juvenile rearing occur in freshwater rivers followed by migration to the marine environment. This listing includes wild Atlantic salmon found in rivers and streams from the lower Kennebec River north to the border between the U.S. and Canada, including the Dennys, East Machias, Machias, Pleasant, Narraguagus, Ducktrap, and Sheepscot Rivers and Cove Brook. While at sea, Atlantic salmon undertake extensive migrations to waters off Canada and Greenland. Data from past commercial harvest indicate that post-smolts overwinter in the southern Labrador Sea and in the Bay of Fundy. Juvenile salmon in New England rivers typically migrate to sea in May after a two to three year period of development in freshwater streams, and remain at sea for two winters before returning to their U.S. natal rivers to spawn from mid October through early November. During the first winter, some of these fish overwinter in the Bay of Fundy.

The abundance of wild, Gulf of Maine Atlantic salmon is perilously small: the total run size of spawning adults in this species numbered approximately 150 animals in 1999 (Baum 2000). Since 1992, no wild Atlantic salmon have been caught in commercial fisheries or by research or survey vessels within the distribution of this species. Because of their current distribution, these Atlantic salmon might only co-occur with the training activities the U.S. Navy proposes to conduct on the Northeast Operating Areas. Because they tend to be distributed in waters off Canada and Greenland and because of their low population size, these salmon are not likely to be exposed to the training activities the U.S. Navy proposed to conduct in the Northeast Operating Areas.

Smalltooth sawfish. Smalltooth sawfish are tropical, marine and estuarine fish that inhabit shallow waters of inshore bars, mangrove edges, and seagrass beds, although they are occasionally found in deeper coastal waters (NMFS 2000). Historically, this species was common in the shallow waters of the Gulf of Mexico and along the eastern seaboard of the United States to North Carolina (rare sightings of this sawfish occurred as far north as New York). Their current range is limited to peninsular Florida, where they are only found with any regularity off the extreme southern portion of the peninsula (off Everglades National Park and Florida Bay). Because of their current distribution, smalltooth sawfish might only be exposed to the training activities the U.S. Navy proposes to conduct on the Jacksonville Range Complex, which remains north of the primary distribution. Therefore, smalltooth sawfish are not likely to be exposed to the training activities the U.S. Navy proposed to conduct in the Jacksonville Range Complex and, therefore, are not likely to be adversely affected by those exercises.

Shortnose sturgeon. Shortnose sturgeon are an anadromous species that occurs along the Atlantic Coast of North America, from the St. John River in Canada to the St. John‘s River in Florida. The recovery plan for shortnose sturgeon recognized 19 distinct, wild populations: New Brunswick, Canada (1 population); Maine (2 populations); Massachusetts (1 population); Connecticut (1 population); New York (1 population); New Jersey and Delaware (1 population); Maryland and Virginia (1 population); North Carolina (1 population); South Carolina (4 populations); Georgia (4 populations); and Florida (2 populations). One partially-landlocked population occurs in Holyoke Pool of the Connecticut River. Another landlocked population may exist in Lake Marion on the Santee River in South Carolina. Because of their coastal distribution, shortnose sturgeon are not likely to be exposed to the training activities the U.S. Navy proposes to conduct on the Northeast Operating Areas or the Virginia Capes, Cherry Point, or Jacksonville Range Complex and, therefore, are not likely to be adversely affected by the proposed exercises.

Atlantic sturgeon. Atlantic sturgeon are an anadromous species that historically occured in 38 rivers along the Atlantic Coast of North America from St. Croix, Maine to the Saint Johns River in Florida. Presently Atlantic sturgeon presence is documented in 36 rivers. The staus review for Atlantic sturgeon (Atlantic Sturgeon Staus Review Team 2007) recognized five distinct wild populations which inhabitat those 35 rivers: Gulf of Maine, New York Bight, Chesapeake Bay, Carolina and South Atlantic. Atlantic sturgeon are "anadromous"; adults spawn in freshwater in the spring and early summer and migrate into "estuarine" and marine waters where they spend most of their lives. In some southern rivers a fall spawning migration may also occur. They spawn in moderately flowing water (46-76 cm/s) in deep parts of large rivers. Sturgeon eggs are highly adhesive and are deposited on bottom substrate, usually on hard surfaces (e.g., cobble). It is likely that cold, clean water is important for proper larval development. Once larvae begin migrating downstream they use benthic structure (especially gravel matrices) as refuges. Juveniles usually reside in estuarine waters for months to years. Subadults and adults live in coastal waters and estuaries when not spawning, generally in shallow (10-50 m depth) nearshore areas dominated by gravel and sand substrates. Long distance migrations away from spawning rivers are common. Because of their coastal distribution, shortnose sturgeon are not likely to be exposed to the training activities the U.S. Navy proposes to conduct on the Northeast Operating Areas or the Virginia Capes, Cherry Point, or Jacksonville Range Complex and, therefore, are not likely to be adversely affected by the proposed exercises.

Critical Habitat

Critical habitat has also been designated for the northern right whale in the Atlantic Ocean in Cape Cod Bay, Great South Channel, and off Georgia and Florida (50 CFR 226.203). Critical habitat for green sea turtles has been designated on Culebra Island, Puerto Rico (50 CFR226.208), for hawksbill sea turtles on Mona and Monita Islands, Puerto Rico (50 CFR 226.209), and for leatherback sea turtles on Sandy Point on Saint Croix in the U.S. Virgin Islands (50 CFR 226.207).

Based on the best scientific and commercial data available, critical habitat that has been designated for green sea turtles, hawksbill sea turtles, and leatherback sea turtles is outside of the area that might be exposed to mid- or high-frequency active sonar associated with the Atlantic Fleet Active Sonar Training. As a result, we conclude that the proposed exercises will not affect designated critical habitat. Therefore, this critical habitat will not be considered further in these opinions. We consider the critical habitat that has been designated for northern right whales further.

3.2 Climate Change

There is now widespread consensus within the scientific community that atmospheric temperatures on earth are increasing (warming) and that this will continue for at least the next several decades (IPCC 2001, Oreskes 2004). There is also consensus within the scientific community that this warming trend will alter current weather patterns and patterns associated with climatic phenomena, including the timing and intensity of extreme events such as heat-waves, floods, storms, and wet-dry cycles. Threats posed by the direct and indirect effects of global climatic change are or will be common to all of the species we discuss in this Opinion. Because of this commonality, we present this narrative here rather than in each of the species-specific narratives that follow.

The IPCC estimated that average global land and sea surface temperature has increased by 0.6°C (±0.2) since the mid-1800s, with most of the change occurring since 1976. This temperature increase is greater than what would be expected given the range of natural climatic variability recorded over the past 1,000 years (Crowley 2000). The IPCC reviewed computer simulations of the effect of greenhouse gas emissions on observed climate variations that have been recorded in the past and evaluated the influence of natural phenomena such as solar and volcanic activity. Based on their review, the IPCC concluded that natural phenomena are insufficient to explain the increasing trend in land and sea surface temperature, and that most of the warming observed over the last 50 years is likely to be attributable to human activities (IPCC 2001). Climatic models estimate that global temperatures would increase between 1.4 to 5.8°C from 1990 to 2100 if humans do nothing to reduce greenhouse gas emissions (IPCC 2001). These projections identify a suite of changes in global climate conditions that are relevant to the future status and trend of endangered and threatened species (Table 7).

Table 7. Phenomena associated with projections of global climate change including levels of confidence associated with projections (Adapted from Campbell-Lendrum and Woodruff 2006, IPCC 2001)

Phenomenon	Confidence in Observed Changes (observed in the latter 20th Century)	Confidence in Projected Changes (during the 21st Century)
Higher maximum temperatures and a greater number of hot days over almost all land areas	Likely	Very likely
Higher minimum temperatures with fewer cold days and frost days over almost all land areas	Very likely	Very likely
Reduced diurnal temperature range over most land areas	Very likely	Very likely
Increased heat index over most land areas	Likely over many areas	Very likely over most areas
More intense precipitation events	Likely over many mid- to high-latitude areas in Northern Hemisphere	Very likely over many areas
Increased summer continental drying and associated probability of drought	Likely in a few areas	Likely over most mid-latitude continental interiors (projections are inconsistent for other areas)
Increase in peak wind intensities in tropical cyclones	Not observed	Likely over some areas
Increase in mean and peak precipitation intensities in tropical cyclones	Insufficient data	Likely over some areas

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 foreseeable future (Houghton *et al.* 2001, McCarthy *et al.* 2001, Parry *et al.* 2007). The direct effects of climate change would result in increases in atmospheric temperatures, changes in sea surface temperatures, changes in patterns of precipitation, and changes in 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.

The indirect effects of climate change would result from changes in the distribution of temperatures suitable for calving and rearing calves, the distribution and abundance of prey, and the distribution and abundance of competitors or predators. For example, variations in the recruitment of krill (*Euphausia superba*) and the reproductive success of krill predators have been linked to variations in sea-surface temperatures and the extent of sea-ice cover during the winter months. Although the IPCC (2001) did not detect significant changes in the extent of Antarctic sea-ice using satellite measurements, Curran (2003) analyzed ice-core samples from 1841 to 1995 and concluded Antarctic sea ice cover had declined by about 20% since the 1950s.

The Antarctic Peninsula, which is the northern extension of the Antarctic continent, contains the richest areas of krill in the Southern Ocean. The extent of sea ice cover around this Peninsula has the highest degree of variability relative to other areas within the distribution of krill. Relatively small changes in climate conditions are likely to exert a strong influence on the seasonal pack-ice zone in the Peninsula area, which is likely to affect densities of krill in this region. Because krill are important prey for baleen whales or form a critical component of the food chains on which baleen whales depend, increasing the variability of krill densities or causing those densities to decline dramatically is likely to have adverse effect on populations of baleen whales in the Southern Ocean.

Reid and Croxall (2001) analyzed a 23-year time series of the reproductive performance of predators that depend on krill for prey — Antarctic fur seals (*Arctocephalus gazella*), gentoo penguins (*Pygoscelis papua*), macaroni penguins (*Eudyptes chrysolophus*), and black-browed albatrosses (*Thalassarche melanophrys*) — at South Georgia Island and concluded that these populations experienced increases in the 1980s followed by significant declines in the 1990s accompanied by an increase in the frequency of years with reduced reproductive success. The authors concluded that macaroni penguins and black-browed albatrosses had declined by as much as 50 percent in the 1990s, although incidental mortalities in longline fisheries probably contributed to the decline of the albatross. These authors concluded, however, that these declines result, at least in part, from changes in the structure of the krill population, particularly reduced recruitment into older age classes, which lowers the number of predators this prey species can 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.

Similarly, a study of relationships between climate and sea-temperature changes and the arrival of squid off southwestern England over a 20-year period concluded that veined squid (*Loligo forbesi*) migrate eastwards in the English Channel earlier when water in the preceding months is warmer, and that higher temperatures and early arrival correspond with warm phases of the North Atlantic oscillation (Sims *et al.* 2001). The timing of squid peak abundance advanced by 120- 150 days in the warmest years compared with the coldest. Seabottom temperatures were closely linked to the extent of squid movement and temperature increases over the five months prior to and during the month of peak squid abundance did not differ between early and late years. These authors concluded that the temporal variation in peak abundance of squid seen off Plymouth represents temperature-dependent movement, which is in turn mediated by climatic changes associated with the North Atlantic Oscillation.

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. Blue whales, as predators that specialize in eating krill, seem likely to change their distribution in response to changes in the distribution of krill (for example, see Payne *et al.* 1986, 1990 and Weinrich 2001); if they did not change their distribution or could not find the biomass of krill necessary to sustain their population numbers, their populations seem likely to experience declines similar to those observed in other krill predators, which would cause dramatic declines in their population sizes or would increase the year-to-year variation in population size; either of these outcomes would dramatically increase the extinction probabilities of these whales.

Sperm whales, whose diets can be dominated by cephalopods, would have to re-distribute following changes in the distribution and abundance of their prey. This statement assumes that projected changes in global climate would only affect the distribution of cephalopod populations, but would not reduce the number or density of cephalopod populations. If, however, cephalopod populations collapse or decline dramatically, sperm whale populations are likely to collapse or decline dramatically as well.

The response of North Atlantic right whales to changes in the North Atlantic Oscillation also provides insight into the potential consequences of a changing climate on large whales. Changes in the climate of the North Atlantic have been directly linked to the North Atlantic Oscillation, which results from variability in pressure differences between a low pressure system that lies over Iceland and a high pressure system that lies over the Azore Islands. As these pressure systems shift from east to west, they control the strength of westerly winds and storm tracks across the North Atlantic Ocean. The North Atlantic Oscillation Index, which is positive when both systems are strong (producing increased differences in pressure that produce more and stronger winter storms) and negative when both systems are weak (producing decreased differences in pressure resulting in fewer and weaker winter storms), varies from year to year, but also exhibits a tendency to remain in one phase for intervals lasting several years.

Sea surface temperatures in the North Atlantic Ocean are closely related to this Oscillation and influences the abundance of marine mammal prey such as zooplankton and fish. In the 1970s and 1980s, the North Atlantic Oscillation Index had been positive and sea surface temperatures increased. These increases are believed to have produced conditions that were favorable for the copepod (*Calanus finmarchicus*), which is the principal prey of North Atlantic right whales (Conversi *et al.* 2001) and may have increased calving rates of these whales (we cannot verify this association because systematic data on North Atlantic right whale was not collected until 1982; Greene *et al.* 2003). In the late 1980s and 1990s, the NAO Index was mainly positive but exhibited two substantial, multi-year reversals to negative values. This was followed by two major, multi-year declines in copepod prey abundance (Pershing *et al.* 2001, Drinkwater *et al.* 2003). Calving rates for North Atlantic right whales followed the declining trend in copepod abundance, although there was a time lag between the two (Greene *et al.* 2003).

Although the NAO Index has been positive for the past 25 years, atmospheric models suggest that increases in ocean temperature associated with climate change forecasts may produce more severe fluctuations in the North Atlantic Oscillation. Such fluctuations would be expected to cause dramatic shifts in the reproductive rate of critically endangered North Atlantic right whales (Drinkwater *et al.* 2003; Greene *et al.* 2003) and possibly a northward shift in the location of right whale calving areas (Kenney 2007).

Changes in global climatic patterns are also projected to have profound effect on the coastlines of every continent by increasing sea levels and increasing the intensity, if not the frequency, of hurricanes and tropical storms. 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 that are destroyed by tropical storms and hurricanes. Further, the combination of increasing sea levels, changes in patterns of coastal erosion and accretion, and changes in rainfall patterns are likely to affect coastal estuaries, submerged aquatic vegetation, and reef ecosystems that provide foraging and rearing habitat for several species of sea turtles. Finally, changes in ocean currents associated with climate change projections would affect the migratory patterns of sea turtles. The loss of nesting beaches, by itself, would have catastrophic effect on sea turtles populations globally if they are unable to colonize any new beaches that form of if the beaches that form do not provide the sand depths, grain patterns, elevations above high tides, or temperature regimes necessary to allow turtle eggs to survive. When combined with changes in coastal habitats and oceans currents, the future climates that are forecast place sea turtles at substantially greater risk of extinction than they already face.

As of the date these Opinions were drafted, we do not know whether the computer models on which these projections are based are accurate or, if so, how far into the future these effects might become manifest because these are long-term projections. Nevertheless, based on the best scientific and commercial data available, none of these effects are likely to affect the status or trend of the endangered or threatened species we considered in our 2009 programmatic biological opinion on training operations in the Virginia capes, Cherry Point and Jacksonville Range Complexes or the activities that would occur during the twelve month interval of the proposed Letters of Authorization.

3.3 Introduction to this Status of Listed Species

The rest of this section of our Opinions 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 proposed training and operations in the U.S. Navy Range Complexes along the Atlantic Coast of the United States and in the Gulf of Mexico from June 2011 to June 2012. In each narrative, we present a summary of information on the distribution and population structure of each species to provides a foundation for the exposure analyses that appear later in this Opinion. 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.

After the Status subsection of each narrative, 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 how the different species are likely to respond to sounds produced by detonations.

More detailed background information on the status of these species and critical habitat can be found in a number of published documents including status reviews and recovery plans for blue whales (NMFS 1998a), fin whales (2007, 2010a), fin and sei whale (NMFS 1998b, NMFS 2007), humpback whale (NMFS 1991a), sperm whale (NMFS 2010b) a status report on large whales prepared by Perry *et al.* (1999), and recovery plans for sea turtles (NMFS and USFWS 1998a, 1998b, 1998c, 1998d, and 1998e) 5-year reviews (NMFS 2007) and status reviews (Conant et al 2009). Richardson *et al.* (1995) and Tyack (2000) provide detailed analyses of the functional aspects of cetacean communication and their responses to active sonar. Finally, Croll *et al.* (1999), NRC (1994, 1996, 2000, 2003, 2005), and Richardson *et al.* (1995) provide information on the potential and probable effects of active sonar on the marine animals considered in these Opinions.

3.4. Blue whale

Distribution

Blue whales are found along the coastal shelves of North America and South America (Rice 1974; Donovan 1984; Clarke 1980) in the North Pacific Ocean. In the North Pacific Ocean, blue whales occur in summer foraging areas in the Chukchi Sea, the Sea of Okhotsk, around the Aleutian Islands, and the Gulf of Alaska; in the eastern Pacific, they occur south to California; in the western Pacific, they occur south to Japan. Blue whales in the eastern Pacific winter from California south; in the western Pacific, they winter from the Sea of Japan, the East China and Yellow Seas, and the Philippine Sea (Gambell 1985).

In the western North Atlantic Ocean, blue whales are found from the Arctic to at least the mid-latitude waters of the North Atlantic (CeTAP 1982, Wenzel *et al.*1988, Yochem and Leatherwood 1985, Gagnon and Clark 1993). Blue whales have been observed frequently off eastern Canada, particularly in waters off Newfoundland, during the winter. 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 Ocean, blue whales have been observed off the Azores Islands, although Reiner *et al.* (1993) do not consider them common in that area.

In 1992, the U.S. Navy conducted an extensive acoustic survey of the North Atlantic using the Integrated Underwater Surveillance System's fixed acoustic array system (Clark 1995). Concentrations of blue whale sounds were detected in the Grand Banks off Newfoundland and west of the British Isles. In the lower latitudes, one blue whale was tracked acoustically for 43 days, during which time the animal traveled 1400 nautical miles around the western North Atlantic from waters northeast of Bermuda to the southwest and west of Bermuda (Gagnon and Clark 1993).

In the North Pacific Ocean, blue whales have been recorded off the island of Oahu in the main Hawai'ian Islands and off Midway Island in the western edge of the Hawai'ian Archipelago (Barlow *et al.* 1994b; Northrop *et al.* 1971; Thompson and Friedl 1982), although blue whales are rarely sighted in Hawai'ian waters and have not been reported to strand in the Hawai'ian Islands. Nishiwaki (1966) reported that blue whales occur in the Aleutian Islands and in the Gulf of Alaska, although blue whales have not been observed off Alaska since 1987 (Leatherwood *et al.* 1982; Stewart *et al.* 1987; Forney and Brownell 1996). No distributional information exists for the western region of the North Pacific.

In the eastern tropical Pacific Ocean, the Costa Rica Dome appears to be important for blue whales based on the high density of prey (euphausiids) available in the Dome and the number of blue whales that appear to reside there (Reilly and Thayer 1990). Blue whales have been sighted in the Dome area in every season of the year, although their numbers appear to be highest from June through November.

Blue whales have also been reported year-round in the northern Indian Ocean, with sightings in the Gulf of Aden, Persian Gulf, Arabian Sea, and across the Bay of Bengal to Burma and the Strait of Malacca (Mizroch *et al.* 1984). The migratory movements of these whales are unknown.

Historical catch records suggest that "true" blue whales and "pygmy" blue whale (*B. m. brevicada*) may be geographically distinct (Brownell and Donaghue 1994, Kato *et al.* 1995). The distribution of the "pygmy" blue whale is north of the Antarctic Convergence, while that of the "true" blue whale is south of the Convergence in the austral summer (Kato *et al.* 1995). "True" blue whales occur mainly in the higher latitudes, where their distribution in mid-summer overlaps with that of the minke whale (*Balaenoptera acutorostrata*). During austral summers, "true" blue whales are found close to edge of Antarctic ice (south of 58° S) with concentrations between 60°-80° E and 66°-70° S (Kasamatsu *et al.* 1996).

Population Structure

For this and all subsequent species, the term "population" refers to groups of individuals whose patterns of increase or decrease in abundance over time are determined by internal dynamics (births resulting from sexual interactions between individuals in the group and deaths of those individuals) rather than external dynamics (immigration or emigration). This definition is a reformulation of definitions articulated by Cole (1957, Futuyma (1986) and Wells and Richmond (1995) and is more restrictive than those uses of 'population' that refer to groups of individuals that co-occur in space and time but do not have internal dynamics that determine whether the size of the group increases or decreases over time (see review by Wells and Richmond 1995). The definition we apply is important to section 7 consultations because such concepts as 'population decline,' 'population collapse,' 'population extinction,' and 'population recovery' apply to the restrictive definition of 'population' but do not explicitly apply to alternative definitions. As a result, we do not treat the different whale "stocks" recognized by the International Whaling Commission or other authorities as populations unless those distinctions were clearly based on demographic criteria. We do, however, acknowledge those "stock" distinctions in these narratives.

At least three subspecies of blue whales have been identified based on body size and geographic distribution (*B. musculus intermedia*, which occurs in the higher latitudes of the Southern Oceans, *B. m. musculus*, which occurs in the Northern Hemisphere, and *B. m. brevicauda* which occurs in the mid-latitude waters of the southern Indian Ocean and north of the Antarctic convergence), but this consultation will treat them as a single entity. Readers who are interested in these subspecies will find more information in Gilpatrick *et al.* (1997), Kato *et al.* (1995), Omura *et al.* (1970) and Ichihara (1966).

In addition to these subspecies, the International Whaling Commission's Scientific Committee has formally recognized one blue whale population in the North Pacific (Donovan 1991), although there is increasing evidence that there may be more than one blue whale population in the Pacific Ocean (Gilpatrick *et al.* 1997, Barlow *et al.* 1995, Mizroch *et al.* 1984a, Ohsumi and Wada 1974). For example, studies of the blue whales that winter off Baja California and in the Gulf of California suggest that these whales are morphologically distinct from blue whales of the western and central North Pacific (Gilpatrick *et al.* 1997), although these differences might result from differences in the productivity of their foraging areas more than genetic differences (the southern whales forage off California; Sears *et al.*1987; Barlow *et al.*1997; Calambokidis *et al.* 1990).

A population or "stock" of endangered blue whales occurs in waters surrounding the Hawai'ian archipelago (from the main Hawai'ian Islands west to at least Midway Island), although blue whales are rarely reported from Hawai'ian waters. The only reliable report of this species in the central North Pacific was a sighting made from a scientific research vessel about 400 km northeast of Hawai'i in January 1964 (nmfs 1998). However, acoustic monitoring has recorded blue whales off Oahu and the Midway Islands much more recently (Barlow *et al.* 1994, McDonald and Fox 1999, Northrop *et al.* 1971; Thompson and Friedl 1982).

The recordings made off Oahu showed bimodal peaks throughout the year, suggesting that the animals were migrating into the area during summer and winter (Thompson and Friedl 1982; McDonald and Fox 1999). Twelve aerial surveys were flown within 25 nm^2 of the main Hawai'ian Islands from 1993-1998 and no blue whales were sighted. Nevertheless, blue whale vocalizations that have been recorded in these waters suggest that the occurrence of blue whales in these waters may be higher than blue whale sightings. There are no reports of blue whales stranding in Hawai'ian waters.

The International Whaling Commission also groups all of the blue whales in the North Atlantic Ocean into one "stock" and groups blue whales in the Southern Hemisphere into six "stocks" (Donovan 1991), which are presumed to follow the feeding distribution of the whales.

Threats to the Species

Natural threats. Natural causes of mortality in blue whales are largely unknown, but probably include predation and disease (not necessarily in their order of importance). Blue whales are known to become infected with the nematode *Carricauda boopis* (Baylis 1920), which are believed to have caused fin whales to die as a result of renal failure (Lambertsen 1986; see additional discussion under *Fin whales*). Killer whales and sharks are also known to attack, injure, and kill very young or sick fin and humpback whale and probably hunt blue whales as well (Perry *et al.* 1999).

Anthropogenic threats. Two human activities are known to threaten blue whales: whaling and shipping. Historically, whaling represented the greatest threat to every population of blue whales and was ultimately responsible for listing blue whales as an endangered species. As early as the mid-seventeenth century, the Japanese were capturing blue, fin, and other large whales using a fairly primitive open-water netting technique (Tønnessen and Johnsen 1982, Cherfas 1989). In 1864, explosive harpoons and steam-powered catcher boats were introduced in Norway, allowing the large-scale exploitation of previously unobtainable whale species. Before fin whales became the focus of whaling operations, populations of blue whales had already become commercially extinct (IWC 1995).

From 1889 to 1965, whalers killed about 5,761 blue whales in the North Pacific Ocean (NMFS 1998). Evidence of a population decline were evident in the catch data from Japan. In 1912, whalers captured 236 blue whales; in 1913, 58 blue whales; in 194, 123 blue whales; from 1915 to 1965, the number of blue whales captured declined continuously (Mizroch *et al.* 1984). In the eastern North Pacific, whalers killed 239 blue whales off the California coast in 1926. And, in the late 1950s and early 1960s, Japanese whalers killed 70 blue whales per year off the Aleutian Islands (Mizroch *et al.* 1984a).

Although the International Whaling Commission banned commercial whaling in the North Pacific in 1966, Soviet whaling fleets continued to hunt blue whales in the North Pacific for several years after the ban. Surveys conducted in these former-whaling areas in the 1980s and 1990s failed to find any blue whales (Forney and Brownell 1996). By 1967, Soviet scientists wrote that blue whales in the North Pacific Ocean (including the eastern Bering Sea and Prince William Sound) had been so overharvested by Soviet whaling fleets that some scientists concluded that any additional harvests were certain to cause the species to become extinct in the North Pacific (Latishev 2007). As its legacy, whaling has reduced blue whales to a fraction of their historic population size and, as a result, makes it easier for other human activities to push blue whales closer to extinction. Otherwise, whaling currently does not threaten blue whale populations.

Ship strikes were implicated in the deaths of five blue whales, from 2004-2008 (Caretta *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. Several blue whales have been photographed in California with large gashes in their dorsal surface that appear to be from ship strikes (J. Calambokidis, pers. comm. *In*:). 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 *et al.* 1983). 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 1987, Macfarlane 1981).

Status

Blue whales were listed as endangered under the ESA in 1973. Blue whales are listed as endangered on the IUCN Red List of Threatened Animals (Baillie and Groombridge 1996). They are also protected by the Convention on International Trade in Endangered Species of wild flora and fauna and the MMPA. Critical habitat has not been designated for blue whales.

It is difficult to assess the current status of blue whales because (1) there is no general agreement on the size of the blue whale population prior to whaling and (2) estimates of the current size of the different blue whale populations vary widely. We may never know the size of the blue whale population prior to whaling, although some authors have concluded that their population numbers about 200,000 animals before whaling. Similarly, estimates of the global abundance of blue whales are uncertain. Since the cessation of whaling, the global population of blue whales has been estimated to range from 11,200 to 13,000 animals (Maser *et al.* 1981; U. S. Department of Commerce 1983). These estimates, however, are more than 20 years old.

A lot of uncertainty surrounds estimates of blue whale abundance in the North Pacific Ocean. Barlow (1994) estimated the North Pacific population of blue whales to number between 1,400 to 1,900. Barlow and Calambokidis (1995) estimated the abundance of blue whales off California at 2,200 individuals. Wade and Gerrodette (1993) and Barlow *et al.* (1997) estimated there were a minimum of 3,300 blue whales in the North Pacific Ocean in the 1990s.

The size of the blue whale population in the north Atlantic is also uncertain. The population has been estimated to number from a few hundred individuals (Allen 1970; Mitchell 1974) to 1,000 to 2,000 individuals (Sigurjónsson 1995). Gambell (1976) estimated that there were between 1,100 and 1,500 blue whales in the North Atlantic before whaling began and Braham (1991) estimated there were between 100 and 555 blue whales in the North Atlantic during the late 1980s and early 1990s. Sears *et al.* (1987) identified over 300 individual blue whales in the Gulf of St. Lawrence, which provides a minimum estimate for their population in the North Atlantic. Sigurjónsson and Gunnlaugson (1990) concluded that the blue whale population had been increasing since the late 1950s and argued that the blue whale population had increased at an annual rate of about 5 percent between 1979 and 1988, although the level of confidence we can place in these estimates is low.

Estimates of the number of blue whales in the Southern Hemisphere range from 5,000 to 6,000 (review by Yochem and Leatherwood 1985) with an average rate of increase that has been estimated at between 4 and 5 percent per year. Butterworth *et al.* (1993), however, estimated the Antarctic population at 710 individuals. More recently, Stern (2001) estimated the blue whale population in the Southern Ocean at between 400 and 1,400 animals (c.v. 0.4). The pygmy blue whale population has been estimated at 6,000 individuals (Yochem and Leatherwood 1985).

The information available on the status and trend of blue whales do not allow us to reach any conclusions about the extinction risks facing blue whales as a species, or particular populations of blue whales. With the limited data available on blue whales, we do not know whether these whales exist at population sizes large enough to avoid demographic phenomena that are known to increase the extinction probability of species that exist as "small" populations (that is, "small" populations experience phenomena such as demographic stochasticity, inbreeding depression and Allee effects, among others, that cause their population size to become a threat in and of itself) or if blue whales are threatened more by exogenous threats such as anthropogenic activities (primarily whaling, entanglement, and ship strikes) or natural phenomena (such as disease, predation, or changes in the distribution and abundance of their prey in response to changing climate).

Diving and Social Behavior

Generally, blue whales make 5-20 shallow dives at 12-20 second intervals followed by a deep dive of 3-30 minutes (Mackintosh 1965; Leatherwood *et al.* 1976; Maser *et al.* 1981; Yochem and Leatherwood 1985; Strong 1990; Croll *et al.* 1999). Croll *et al.* (1999) found that the dive depths of blue whales foraging off the coast of California during the day averaged 132 m (433 ft) with a maximum recorded depth of 204 m (672 ft) and a mean dive duration of 7.2 minutes. Nighttime dives are generally less than 50 m (165 ft) in depth (Croll *et al.* 1999).

Blue whales are usually found swimming alone or in groups of two or three (Ruud 1956, Slijper 1962, Nemoto 1964, Mackintosh 1965, Pike and MacAskie 1969, Aguayo 1974). However, larger foraging aggregations and aggregations mixed with other species like fin whales are regularly reported (Schoenherr 1991, Fiedler *et al.* 1998). Little is known of the mating behavior of blue whales.

Vocalizations and Hearing

The vocalizations that have been identified for blue whales include a variety of sounds described as low frequency moans or long pulses (Cummings and Thompson 1971, 1977; Edds 1982, Thompson and Friedl 1982; Edds-Walton 1997). Blue whales produce a variety of low frequency sounds in the 10-100 Hz band (Cummings and Thompson 1971, Edds 1982, Thompson and Friedl 1982, McDonald *et al.* 1995, Clark and Fristrup 1997, Rivers 1997). The most typical signals are very long, patterned sequences of tonal infrasonic sounds in the 15-40 Hz range. The sounds last several tens of seconds. Estimated source levels are as high as 180-190 dB (Cummings and Thompson 1971). Ketten (1997) reports the frequencies of maximum energy between 12 and 18 Hz. 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 and Thompson 1971, 1977, 1994; Cummings and Fish 1972; Thompson *et al.* 1996; Rivers 1997; Tyack and Clark 1997; Clark *et al.* 1998).

Blue whale moans within the low frequency range of 12.5-200 Hz, with pulse duration up to 36 seconds, have been recorded off Chile (Cummings and Thompson 1971). A short, 390 Hz pulse also is produced during the moan. One estimate of the overall source level was as high as 188 dB, with most energy in the 1/3-octave bands centered at 20, 25, and 31.5 Hz, and also included secondary components estimates near 50 and 63 Hz (Cummings and Thompson 1971).

As with other vocalizations produced by baleen whales, the function of blue whale vocalizations is unknown, although there are numerous hypotheses (which include: maintenance of inter-individual distance, species and individual recognition, contextual information transmission, maintenance of social organization, location of topographic features, and location of prey resources; see the review by Thompson *et al.* 1992 for more information on these hypotheses). Responses to conspecific sounds have been demonstrated in a number of mysticetes, and there is no reason to believe that fin whales do not communicate similarly (Edds-Walton 1997). The low-frequency sounds produced by blue whales can, in theory, travel long distances, and it is possible that such long-distance communication occurs (Payne and Webb 1971, Edds-Walton 1997). The long-range sounds may also be used for echolocation in orientation or navigation (Tyack 1999).

Cetaceans have an auditory anatomy that follows the basic mammalian pattern, with some modifications to adapt to the demands of hearing in the sea. The typical mammalian ear is divided into the outer ear, middle ear, and inner ear. The outer ear is separated from the inner ear by the tympanic membrane, or eardrum. In terrestrial mammals, the outer ear, eardrum, and middle ear function to transmit airborne sound to the inner ear, where the sound is detected in a fluid. Since cetaceans already live in a fluid medium, they do not require this matching, and thus do not have an air-filled external ear canal. The inner ear is where sound energy is converted into neural signals that are transmitted to the central nervous system via the auditory nerve. Acoustic energy causes the basilar membrane in the cochlea to vibrate. Sensory cells at different positions along the basilar membrane are excited by different frequencies of sound (Tyack 1999). Baleen whales have inner ears that appear to be specialized for low-frequency hearing. In a study of the morphology of the mysticete auditory apparatus, Ketten (1997) hypothesized that large mysticetes have acute infrasonic hearing.

3.5 Fin whale

Distribution

Fin whales are distributed widely in every ocean except the Arctic Ocean. In the North Pacific Ocean, fin whales occur in summer foraging areas in the Chukchi Sea, the Sea of Okhotsk, around the Aleutian Islands, and the Gulf of Alaska; in the eastern Pacific, they occur south to California; in the western Pacific, they occur south to Japan. Fin whales in the eastern Pacific winter from California south; in the western Pacific, they winter from the Sea of Japan, the East China and Yellow Seas, and the Philippine Sea (Gambell 1985).

In the North Atlantic Ocean, fin whales occur in summer foraging areas from the coast of North America to the Arctic, around Greenland, Iceland, northern Norway, Jan Meyers, Spitzbergen, and the Barents Sea. In the western Atlantic, they winter from the edge of sea ice south to the Gulf of Mexico and the West Indies. In the eastern Atlantic, they winter from southern Norway, the Bay of Biscay, and Spain with some whales migrating into the Mediterranean Sea (Gambell 1985).

In the Southern Hemisphere, fin whales are distributed broadly south of 50° S in the summer and migrate into the Atlantic, Indian, and Pacific Oceans in the winter, along the coast of South America (as far north as Peru and Brazil), Africa, and the islands in Oceania north of Australia and New Zealand (Gambell 1985).

Fin whales are common off the Atlantic coast of the United States in waters immediately off the coast seaward to the continental shelf (about the 1,000-fathom contour). In this region, they tend to occur north of Cape Hatteras, where they accounted for about 46 percent of the large whales observed in surveys conducted between 1978 and 1982. During the summer months, fin whales in this region tend to congregate in feeding areas between 41°20'N and 51°00'N, from shore seaward to the 1,000-fathom contour.

In the Atlantic Ocean, Clark (1995) reported a general southward pattern of fin whale migration in the fall from the Labrador and Newfoundland region, south past Bermuda, and into the West Indies. The overall distribution may be based on prey availability, and fin whales are found throughout the action area for this consultation in most months of the year. This species preys opportunistically on both invertebrates and fish (Watkins *et al.* 1984). They feed by filtering large volumes of water for the associated prey. Fin whales are larger and faster than humpback and right whales and are less concentrated in nearshore environments.

Population Structure

Fin whales have two recognized subspecies: *Balaoptera physalus physalus* (Linnaeus 1758) occurs in the North Atlantic Ocean while *B. p.* ***.*** *quoyi* (Fischer 1829) occurs in the Southern Ocean. Globally, fin whales are sub-divided into three major groups: Atlantic, Pacific, and Antarctic. Within these major areas, different organizations use different population structure.

In the North Atlantic Ocean, the International Whaling Commission recognizes seven management units or "stocks" of fin whales: (1) Nova Scotia, (2) Newfoundland-Labrador, (3) West Greenland, (4) East Greenland-Iceland, (5) North Norway, (6) West Norway-Faroe Islands, and (7) British Isles-Spain-Portugal. In addition, the population of fin whales that resides in the Ligurian Sea, in the northwestern Mediterranean Sea, is believed to be genetically distinct from other fin whales populations (as used in this Opinion, "populations" are isolated demographically, meaning, they are driven more by internal dynamics — birth and death processes — than by the geographic redistribution of individuals through immigration or emigration. Some usages of the term "stock" are synonymous with this definition of "population" while other usages of "stock" are not).

In the North Pacific Ocean, the International Whaling Commission recognizes two "stocks": (1) East China Sea and (2) rest of the North Pacific (Donovan, 1991). However, Mizroch *et al.* (1984) concluded that there were five possible "stocks" of fin whales within the North Pacific based on histological analyses and tagging experiments: (1) East and West Pacific that intermingle around the Aleutian Islands; (2) East China Sea; (3) British Columbia; (4) Southern-Central California to Gulf of Alaska; and (5) Gulf of California. Based on genetic analyses, Berube *et al.* (1998) concluded that fin whales in the Sea of Cortez represent an isolated population that has very little genetic exchange with other populations in the North Pacific Ocean (although the geographic distribution of this population and other populations can overlap seasonally). They also concluded that fin whales in the Gulf of St. Lawrence and Gulf of Maine are distinct from fin whales found off Spain and in the Mediterranean Sea.

Regardless of how different authors structure the fin whale population, mark-recapture studies have demonstrated that individual fin whales migrate between management units (Mitchell 1974; Gunnlaugsson and Sigurjónsson 1989), which suggests that these management units are not geographically isolated populations.

Mizroch *et al.* (1984) identified five fin whale “feeding aggregations” in the Pacific Ocean: (1) eastern and western groups that move along the Aleutians (Berzin and Rovnin 1966; Nasu 1974); (2) an East China Sea group; (3) a group that moves north and south along the west coast of North America between California and the Gulf of Alaska (Rice 1974); and (4) a group centered in the Sea of Cortez (Gulf of California).

Hatch (2004) reported that fin whale vocalizations among five regions of the eastern North Pacific were heterogeneous: the Gulf of Alaska, the northeast North Pacific (Washington and British Columbia), the southeast North Pacific (California and northern Baja California), the Gulf of California, and the eastern tropical Pacific.

Sighting data show no evidence of migration between the Sea of Cortez and adjacent areas in the Pacific, but seasonal changes in abundance in the Sea of Cortez suggests that these fin whales might not be isolated (Tershy *et al.* 1993). Nevertheless, Bérubé *et al.* (2002) concluded that the Sea of Cortez fin whale population is genetically distinct from the oceanic population and has lower genetic diversity, which suggests that these fin whales might represent an isolated population.

In its final recovery plan for fin whales, NMFS recognized three populations in U.S. Pacific waters: Alaska (Northeast Pacific), California/Oregon/Washington, and Hawai’i (Barlow *et al.* 1997; Hill *et al.* 1997). We assume that individuals from the latter “population” of fin whales are the whales that would be exposed to the activities considered in this consultation.

Threats to the Species

Natural threats. Natural sources and rates of mortality are largely unknown, but Aguilar and Lockyer (1987) suggest annual natural mortality rates may range from 0.04 to 0.06. Although these results are based on studies of fin whales in the northeast Atlantic, there are no comparable estimates for fin whales in the Pacific Ocean. The occurrence of the nematode *Crassicauda boopis* appears to increase the potential for kidney failure in fin whales and may be preventing some fin whale stocks from recovering from whaling (Lambertsen 1992, as cited in Perry *et al.* 1999). Killer whale or shark attacks may injure or kill very young or sick whales (Perry *et al.* 1999, Tomilin 1967).

Anthropogenic threats. Three human activities are known to threaten fin whales: whaling, commercial fishing, and shipping. Historically, whaling represented the greatest threat to every population of fin whales and was ultimately responsible for listing fin whales as an endangered species. As early as the mid-seventeenth century, the Japanese were capturing fin, blue (*Balaenoptera musculus*), and other large whales using a fairly primitive open-water netting technique (Tønnessen and Johnsen 1982, Cherfas 1989). In 1864, explosive harpoons and steam-powered catcher boats were introduced in Norway, allowing the large-scale exploitation of previously unobtainable whale species. After blue whales were depleted in most areas, fin whales became the focus of whaling operations and more than 700,000 fin whales were landed in the Southern Hemisphere alone between 1904 and 1979 (IWC 1995).

As its legacy, whaling has reduced fin whales to a fraction of their historic population size and, as a result, makes it easier for other human activities to push fin whales closer to extinction. Otherwise, whaling currently does not threaten every fin whale population, although it may threaten specific populations.

From 1904 to 1975, the International Whaling Commission estimates that 703,693 fin whales were captured and killed in Antarctic whaling operations (IWC 1990). Whaling in the Southern Oceans originally targeted humpback whales, but by 1913, those whales had became rare so whalers shifted their focus to fin and blue whales (Mizroch *et al.* 1984b). From 1911 to 1924, whalers killed 2,000–5,000 fin whales each year. After the introduction of factory whaling ships in 1925, the number of whales killed each year increased substantially: from 1931 to 1972, whalers killed about 511,574 fin whales (Kawamura 1994). In 1937 alone, whalers are reported to have killed more than 28,000 fin whales. From 1953 to 1961, the number of fin whales killed each year averaged around 25,000. In 1962, whalers appeared to shift their focus to sei whale as fin whales became scarce. By 1974, whalers killed fewer than 1,000 fin whales.

Recently released Soviet whaling records indicate a discrepancy between reported and actual fin whale catch numbers by whalers from the former USSR in southern waters between 1947 and 1980 (Zemsky *et al.* 1995). The former USSR previously reported 52,931 whales caught; however, the data that was released recently suggests that only 41,984 were killed.

In the Antarctic Ocean, fin whales are hunted by Japanese whalers for its scientific whaling program under an Antarctic Special Permit. Japan started killing fin whales in its 2005–2006 program season and increased its target from 10 to 50 fin whales for the next twelve seasons beginning with the 2007/2008 season. Japan took zero fin whales in the 2007/2008 season and one in the 2008/2009 season (NMFS 2010a); however, in 2009 and the 2009/2010 seasons Japan killed a total of one fin whale in Antarctica (IWC 2010).

In the Atlantic Ocean fin whales are also hunted in subsistence fisheries off West Greenland and Iceland. In 2004, 5 males and 6 females were killed and landed; 2 other fin whales were struck and lost in the same year off West Greenland. In 2003 2 males and 4 females were landed and 2 other fin whales were struck and lost off West Greenland (IWC 2005). Between 2003 and 2007, the IWC set a catch limit of up to 19 fin whales in the West Greenland subsistence fishery (IWC 2005), however, the IWC's Scientific Committee recommended limiting the number of fin whale killed in this fishery to 1 to 4 individuals until accurate population estimates are produced. Seven fin whales were killed, 2 struck and lost and 1 reported killed as an infraction in 2009 and the 2009/2010 seasons combined (IWC 2010). Another 125 fin whales with 2 reported as infractions were killed off Iceland in 2009 and the 2009/2010 seasons combined (IWC 2010).

Despite anecdotal observations from fishermen which suggest that large whales swim through their nets rather than get caught in them (NMFS 2000), fin whales have been entangled by fishing gear off Newfoundland and Labrador in small numbers: a total of 14 fin whales are reported to have been captured in coastal fisheries in those two provinces between 1969 and 1990 (Lien 1994, Perkins and Beamish 1979). Of these 14 fin whales, 7 are known to have died as a result of that capture, although most of the animals that died were less than 15 meters in length (Lien 1994). Between 1999 and 2005, there were 10 confirmed reports of fin whales being entangled in fishing gear along the Atlantic Coast of the U.S. and the Maritime Provinces of Canada (Cole *et al.* 2005, Nelson *et al.* 2007). Of these reports, Fin whales were injured in 1 of the entanglements and killed in 3 entanglements. These data suggest that, despite their size and strength, fin whales are likely to be entangled and, in some cases, killed by gear used in modern fisheries.

Fin whales are also killed and injured in collisions with vessels more frequently than any other whale. Of 92 fin whales that stranded along the Atlantic Coast of the U.S. between 1975 and 1996, 31 (33%) showed evidence of collisions with ships (Laist *et al.* 2001). Between 1999 and 2005, there were 15 reports of fin whales being struck by vessels along the Atlantic Coast of the U.S. and the Maritime Provinces of Canada (Cole *et al.* 2005, Nelson *et al.* 2007). Of these reports, 13 were confirmed as ship strikes which were reported as having resulted in the death of 11 fin whales.

Ship strikes were identified as a known or potential cause of death in 8 (20%) of 39 fin whales that stranded on the coast of Italy in the Mediterranean Sea between 1986 and 1997 (Laist *et al.* 2001). Throughout the Mediterranean Sea, 46 of the 287 fin whales that are recorded to have stranded between 1897 and 2001 were confirmed to have died from injuries sustained by ship strikes (Panigada *et al.* 2006). 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 2003).

Status

Fin whales were listed as endangered under the ESA in 1970. In 1976, the IWC protected fin whales from commercial whaling (Allen 1980). Fin whales are listed as endangered on the IUCN Red List of Threatened Animals (Baillie and Groombridge 1996). They are also protected by the Convention on International Trade in Endangered Species of wild flora and fauna and the MMPA. Critical habitat has not been designated for fin whales.

It is difficult to assess the current status of fin whales because (1) there is no general agreement on the size of the fin whale population prior to whaling and (2) estimates of the current size of the different fin whale populations vary widely (NMFS 2007). We may never know the size of the fin whale population prior to whaling. The most current estimate of the population size of fin whales in the Pacific Ocean is 85,200 (no coefficient of variance or confidence interval was provided) based on the history of catches and trends in catches per unit of effort (IWC 1979). Based on surveys conducted south of 30°S latitude between 1978 and 1988, fin whales in the Southern Ocean were estimated to number about 400,000 (IWC 1979; no coefficient of variance or confidence interval was provided).

Chapman (1976) estimated the "original" population size of fin whales off Nova Scotia as 1,200 and 2,400 off Newfoundland, although he offered no explanation or reasoning to support that estimate. Sergeant (1977) suggested that between 30,000 and 50,000 fin whales once populated the North Atlantic Ocean based on assumptions about catch levels during the whaling period. 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. More recently, Palumbi and Roman (2006) estimated that about 360,000 fin whales (95% confidence interval = 249,000 - 481,000) populated the North Atlantic Ocean before whaling based on mutation rates and estimates of genetic diversity.

Similarly, estimates of the current size of the different fin whale populations and estimates of their global abundance also vary widely. The final recovery plan for fin whales accepts a minimum population estimate of 2,362 fin whales for the North Atlantic Ocean (NMFS 2007); however, the recovery plan also states that this estimate, which is based on shipboard and aerial surveys conducted in the Georges Bank and Gulf of St. Lawrence in 1999 is the "best" estimate of the size of this fin whale population (NMFS 2006, 2007). However, based on data produced by surveys conducted between 1978-1982 and other data gathered between 1966 and 1989, Hain *et al.* (1992) estimated that the population of fin whales in the western North Atlantic Ocean (specifically, between Cape Hatteras, North Carolina, and Nova Scotia) numbered about 1,500 whales in the winter and 5,000 whales in the spring and summer. Because authors do not always reconcile "new" estimates with earlier estimates, it is not clear whether the current "best" estimate represents a refinement of the estimate that was based on older data or whether the fin whale population in the North Atlantic has declined by about 50% since the early 1980s.

The East Greenland-Iceland fin whale population was estimated at 10,000 animals (95 % confidence interval = 7,600 - 14,200), based on surveys conducted in 1987 and 1989 (Buckland *et al.* 1992). The number of eastern Atlantic fin whales, which includes the British Isles-Spain-Portugal population, has been estimated at 17,000 animals (95% confidence interval = 10,400 -28,900; Buckland *et al.* 1992). These estimates are both more than 15 years old and the data available do not allow us to determine if they remain valid.

Forcada *et al.* (1996) estimated there were 3,583 fin whales in the western Mediterranean (standard error = 967; 95% confidence interval = 2,130 - 6,027), which is similar to an estimate published by Notarbartolo-di-Sciara *et al.* (2003). In the Mediterraneans' Ligurian Sea (which includes the Pelagos Whale Sanctuary and the Gulf of Lions), Forcada *et al.* (1995) estimated there were 901 fin whales (standard error = 196.1).

Regardless of which of these estimates, if any, come closest to actual population sizes, these estimates suggest that the global population of fin whales consists of tens of thousands of individuals. Based on ecological theory and demographic patterns derived from several hundred imperiled species and populations, fin whales appear to exist at population sizes that are large enough to avoid demographic phenomena that are known to increase the extinction probability of species that exist as “small” populations (that is, “small” populations experience phenomena such as demographic stochasticity, inbreeding depression and Allee effects, among others, that cause their population size to become a threat in and of itself). As a result, we assume that fin whales are likely to be threatened more by exogenous threats such as anthropogenic activities (primarily whaling, entanglement, and ship strikes) or natural phenomena (such as disease, predation, or changes in the distribution and abundance of their prey in response to changing climate) than endogenous threats caused by the small size of their population.

Nevertheless, based on the evidence available, the number of fin whales that are recorded to have been killed or injured in the past 20 years by human activities or natural phenomena, does not appear to be increasing the extinction probability of fin whales, although it may slow the rate at which they recover from population declines that were caused by commercial whaling.

Diving and Social Behavior

The percentage of time fin whales spend at the surface varies. Some authors have reported that fin whales make 5-20 shallow dives with each of these dives lasting 13-20 seconds followed by a deep dive lasting between 1.5 and 15 minutes (Gambell 1985). Other authors have reported that the fin whale’s most common dives last between 2 and 6 minutes, with 2 to 8 blows between dives (Hain *et al.* 1992, Watkins 1981).

In waters off the Atlantic Coast of the U.S. individual fin whales or pairs represented about 75% of the fin whales observed during the Cetacean and Turtle Assessment Program (Hain *et al.* 1992). Individual whales or groups of less than five individuals represented about 90% of the observations (out of 2,065 observations of fin whales, the mean group size was 2.9, the modal value was 1, and the range was 1 – 65 individuals; Hain *et al.* 1992).

Vocalizations and Hearing

The sounds fin whales produce underwater are one of the most studied *Balaenoptera* sounds. Fin whales produce a variety of low-frequency sounds in the 10-200 Hz band (Watkins 1981; Watkins *et al.* 1987a; Edds 1988; Thompson *et al.* 1992). The most typical signals are long, patterned sequences of short duration (0.5-2s) infrasonic pulses in the 18-35 Hz range (Patterson and Hamilton 1964). Estimated source levels are as high as 190 dB (Patterson and Hamilton 1964; Watkins *et al.* 1987a; Thompson *et al.* 1992; McDonald *et al.* 1995). 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 (Clark and Charif 1998). Short sequences of rapid pulses in the 20-70 Hz band are associated with animals in social groups (McDonald *et al.* 1995, Clark personal communication, McDonald personal communication). Each pulse lasts on the order of one second and contains twenty cycles (Tyack 1999).

During the breeding season, fin whales produce a series of pulses in a regularly repeating pattern. These bouts of pulsing may last for longer than one day (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.* (1995) 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.* 1992).

As with other vocalizations produced by baleen whales, the function of fin whale vocalizations is unknown, although there are numerous hypotheses (which include: maintenance of inter-individual distance, species and individual recognition, contextual information transmission, maintenance of social organization, location of topographic features, and location of prey resources; see the review by Thompson *et al.* 1992 for more information on these hypotheses). Responses to conspecific sounds have been demonstrated in a number of mysticetes, and there is no reason to believe that fin whales do not communicate similarly (Edds-Walton 1997). The low-frequency sounds produced by fin whales have the potential to travel over long distances, and it is possible that long-distance communication occurs in fin whales (Payne and Webb 1971; Edds-Walton 1997). Also, there is speculation that the sounds may function for long-range echolocation of large-scale geographic targets such as seamounts, which might be used for orientation and navigation (Tyack 1999).

3.6. Humpback Whale

Distribution

Humpback whales are a cosmopolitan species that occur in the Atlantic, Indian, Pacific, and Southern Oceans. Humpback whales migrate seasonally between warmer, tropical or sub-tropical waters in winter months (where they reproduce and give birth to calves) and cooler, temperate or sub-Arctic waters in summer months (where they feed). In their summer foraging areas and winter calving areas, humpback whales tend to occupy shallower, coastal waters; during their seasonal migrations, however, humpback whales disperse widely in deep, pelagic waters and tend to avoid shallower coastal waters (Winn and Reichley 1985).

In the North Pacific Ocean, the summer range of humpback whales includes coastal and inland waters from Point Conception, California, north to the Gulf of Alaska and the Bering Sea, and west along the Aleutian Islands to the Kamchatka Peninsula and into the Sea of Okhotsk (Tomlin 1967, Nemoto 1957, Johnson and Wolman 1984 as cited in NMFS 1991b). These whales migrate to Hawai'i, southern Japan, the Mariana Islands, and Mexico during the winter.

In the Atlantic Ocean, humpback whales range from the mid-Atlantic bight, the Gulf of Maine, across the southern coast of Greenland and Iceland, and along coast of Norway in the Barents Sea. These humpback whales migrate to the western coast of Africa and the Caribbean Sea during the winter.

In the Southern Ocean, humpback whales occur in waters off Antarctica. These whales migrate to the waters off Venezuela, Brazil, southern Africa, western and eastern Australia, New Zealand, and islands in the southwest Pacific during the austral winter. A separate population of humpback whales appears to reside in the Arabian Sea in the Indian Ocean off the coasts of Oman, Pakistan, and India (Mikhalev 1997).

Population Structure

Descriptions of the population structure of humpback whales differ depending on whether an author focuses on where humpback whales winter or where they feed. During winter months in northern or southern hemispheres, adult humpback whales migrate to specific areas in warmer, tropical waters to reproduce and give birth to calves. During summer months, humpback whales migrate to specific areas in northern temperate or sub-arctic waters to forage. In summer months, humpback whales from different "reproductive areas" will congregate to feed; in the winter months, whales will migrate from different foraging areas to a single wintering area. In either case, humpback whales appear to form "open" populations; that is, populations that are connected through the movement of individual animals.

North Pacific Ocean. NMFS' Stock Assessment Reports recognize four "stocks" of humpback whales in the North Pacific Ocean, based on genetic and photo-identification studies: two Eastern North Pacific stocks, one Central North Pacific stock, and one Western Pacific stock (Hill and DeMaster 1998). The first two of these "stocks" are based on where these humpback whales winter: the central North Pacific "stock" winters in the waters around Hawai'i while the eastern North Pacific "stock" (also called the California-Oregon-Washington-Mexico stock) winters along coasts of Central America and Mexico. However, Calambokidis *et al.* (1997) identified humpback whales from Southeast Alaska (central North Pacific), the California-Oregon-Washington (eastern North Pacific), and Ogasawara Islands (Japan, Western Pacific) groups in the Hawai'ian Islands during the winter; humpback whales from the Kodiak Island, Southeast Alaska, and British Columbia groups in the Ogasawara Islands; and whales from the British Columbia, Southeast Alaska, Prince William Sound, and Shumagin-Aleutian Islands groups in Mexico.

Herman (1979), however, presented extensive evidence and various lines of reasoning to conclude that the humpback whales associated with the main Hawai'ian Islands immigrated to those waters only in the past 200 years. Winn and Reichley (1985) identified genetic exchange between the humpback whales that winter off Hawai'i and those that winter off Mexico (with further mixing on feeding areas in Alaska) and suggested that the humpback whales that winter in Hawai'i may have emigrated from wintering areas in Mexico. Based on these patterns of movement, we conclude that the various "stocks" of humpback whales are not true populations or, at least, they represent populations that experience substantial levels of immigration and emigration.

A "population" of humpback whales winters in an area extending from the South China Sea east through the Philippines, Ryukyu Retto, Ogasawara Gunto, Mariana Islands, and Marshall Islands (Rice 1998). Based on whaling records, humpback whales wintering in this area have also occurred in the southern Marianas through the month of May (Eldredge 1991). There are several recent records of humpback whales in the Mariana Islands, at Guam, Rota, and Saipan during January through March (Darling and Mori 1993; Eldredge 1991, 2003; Taitano 1991). During the summer, whales from this population migrate to the Kuril Islands, Bering Sea, Aleutian Islands, Kodiak, Southeast Alaska, and British Columbia to feed (Angliss and Outlaw 2007, Calambokidis 1997, 2001).

Between 2004 and 2006, an international group of whale researchers coordinated their surveys to conduct a comprehensive assessment of the population structure, levels of abundance, and status of humpback whales in the North Pacific (Calambokidis *et al.* 2008). That effort identified a total of 7,971 unique individuals from photographs taken during close approaches. Based on the data collected during that study, Calabmokidis *et al.* (2008) estimated the rates of exchange among humpback whales in different areas in the Hawai'ian Islands.

North Atlantic Ocean. In the Atlantic Ocean, humpback whales aggregate in four feeding areas in the summer months: (1) Gulf of Maine, eastern Canada, (2) west Greenland, (3) Iceland and (4) Norway (Katona and Beard 1990, Smith *et al.* 1999). The principal breeding range for these whales lies from the Antilles and northern Venezuela to Cuba (Winn *et al.* 1975, Balcomb and Nichols 1982, Whitehead and Moore 1982). The largest contemporary breeding aggregations occur off the Greater Antilles where humpback whales from all of the North Atlantic feeding areas have been identified from photographs (Katona and Beard 1990, Clapham *et al.* 1993b, Mattila *et al.* 1994, Palsbøll *et al.* 1997, Smith *et al.* 1999, Stevick *et al.* 2003a). Historically, an important breeding aggregation was located in the eastern Caribbean based on the important humpback whale fisheries this region supported (Mitchell and Reeves 1983, Reeves *et al.* 2001, Smith and Reeves 2003). Although sightings persist in those areas, modern humpback whale abundance appears to be low (Winn *et al.* 1975, Levenson and Leapley 1978, Swartz *et al.* 2003). Winter aggregations also occur at the Cape Verde Islands in the Eastern North Atlantic (Reiner *et al.* 1996, Reeves *et al.* 2002, Moore *et al.* 2003). In another example of the "open" structure of humpback whale populations, an individual humpback whale migrated from the Indian Ocean to the South Atlantic Ocean and demonstrated that individual whales may migrate from one ocean basin to another (Pomilla and Rosenbaum 2005).

Indian Ocean. As discussed previously, a separate population of humpback whales appears to reside in the Arabian Sea in the Indian Ocean off the coasts of Oman, Pakistan, and India (Mikhalev 1997).

Threats to the Species

Natural Threats. There is limited information on natural phenomena that kill or injure humpback whales. We know that humpback whales are killed by orcas (Dolphin 1989, Florez-González *et al.* 1984, Whitehead and Glass 1985) and are probably killed by false killer whales and sharks. Because 7 female and 7 male humpback whales stranded on the beaches of Cape Cod and had died from toxin produced by dinoflagellates between November 1987 and January 1988, we also know that adult and juvenile humpback whales are killed by naturally-produced biotoxins (Geraci *et al.* 1989).

Other natural sources of mortality, however, remain largely unknown. Similarly, we do not know whether and to what degree natural mortality limits or restricts patterns of growth or variability in humpback whale populations.

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 humpback whales and was ultimately responsible for listing humpback whales as an endangered species. From 1900 to 1965, nearly 30,000 whales were taken in modern whaling operations of the Pacific Ocean. Prior to that, an unknown number of humpback whales were taken (Perry *et al.* 1999). In 1965, the International Whaling Commission banned commercial hunting of humpback whales in the Pacific Ocean. As its legacy, whaling has reduced humpback whales to a fraction of their historic population size and, as a result, makes it easier for other human activities to push these whales closer to extinction.

Humpback whales are also killed or injured during interactions with commercial fishing gear. Like fin whales, humpback whales have been entangled by fishing gear off Newfoundland and Labrador, Canada: a total of 595 humpback whales are reported to have been captured in coastal fisheries in those two provinces between 1969 and 1990 (Lien 1994, Perkins and Beamish 1979). Of these whales, 94 are known to have died as a result of that capture, although, like fin whales, most of the animals that died were smaller: less than 12 meters in length (Lien 1994). These data suggest that, despite their size and strength, humpback whales are likely to be entangled and, in some cases, killed by gear used in modern fisheries.

There are also reports of entangled humpback whales from the Hawai'ian 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 Hawai'i 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 Hawai'ian waters; 16 of these reports were from 2005 and 2006.

Many of the entangled humpback whales observed in Hawai'ian 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 Hawai'ian Islands have been confirmed to have been entangled in gear from Alaska. Nevertheless, humpback whales are also entangled in fishing gear in the Hawai'ian Islands. Since 2001, there have been 5 observed interactions between humpback whales and gear associated with the Hawai'i-based longline fisheries (NMFS 2008). 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.

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.* 2005, Nelson *et al.* 2007). Of these reports, 95 entanglements were confirmed resulting in the injury of 11 humpback whales and the death of 9 whales. No information is available on the number of humpback whales that have been killed or seriously injured by interactions with fishing fleets outside of U.S. waters.

The number of humpback whales killed by ship strikes is exceeded only by 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). The humpback whale calf that was found stranded on Oahu with evidence of vessel collision (propeller cuts) in 1996 suggests that ship collisions might kill adults, juvenile, and calves (nmfs unpublished data). 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.* 2005, Nelson *et al.* 2007). Of these reports, 13 were confirmed as ship strikes which were reported as having resulted in the death of 7 humpback whales. Despite several literature searches, we did not identify information on the number of humpback whales killed or seriously injured by ship strikes outside of U.S. waters.

In addition to ship strikes in North America and Hawai'i, there are several reports of humpback whales being injured as a result of ship strikes off the Antarctic Peninsula, in the Caribbean Sea, the Mediterranean Sea, off Australia, Bay of Bengal (Indian Ocean), Brazil, New Zealand, Peru, South Africa, Spain, the United Kingdom and other areas of the United States.

Status

Humpback whales were listed as endangered under the ESA in 1973. Humpback whales are listed as endangered on the IUCN Red List of Threatened Animals (Baillie and Groombridge 1996). They are also protected by the Convention on International Trade in Endangered Species of wild flora and fauna and the MMPA. Critical habitat has not been designated for humpback whales.

It is difficult to assess the current status of humpback whales for the same reasons that it is difficult to assess the status of fin whales: (1) there is no general agreement on the size of the humpback whale population prior to whaling and (2) estimates of the current size of the different humpback whale populations vary widely and produce estimates that are not always comparable to one another, although robust estimates of humpback whale populations in the western North Atlantic have been published. We may never know the size of the humpback whale population prior to whaling.

Winn and Reichley (1985) argued that the global population of humpback whales consisted of at least 150,000 whales in the early 1900s, with the largest population historically occurring in the Southern Ocean. Based on analyses of mutation rates and estimates of genetic diversity, Palumbi and Roman (2006) concluded that there may have been as many as 240,000 (95% confidence interval = 156,000 – 401,000) humpback whales in the North Atlantic before whaling began. In the western North Atlantic between Davis Strait, Iceland and the West Indies, Mitchell and Reeves (1983) estimated there were at least 4,685 humpback whales in 1865 based on available whaling records (although the authors note that this does not represent a “pre-exploitation estimate” because whalers from Greenland, the Gulf of St. Lawrence, New England, and the Caribbean Sea had been hunting humpback whales before 1865).

Estimates of the number of humpback whales occurring in the different populations that inhabit the Northern Pacific population have risen over time. In the 1980s, the size of the North Pacific humpback whale population was estimated to range from 1,407 to 2,100 (Baker 1985; Darling and Morowitz 1986; Baker and Herman 1987). By the mid-1990s, the population was estimated to consist of about 6,000 whales (standard error = 474) in the North Pacific (Calambokidis *et al.* 1997; Cerchio 1998; Mobley *et al.* 1999).

As discussed previously, between 2004 and 2006, an international group of whale researchers coordinated their surveys to conduct a comprehensive assessment of the population structure, levels of abundance, and status of humpback whales in the North Pacific (Calambokidis *et al.* 2008). That effort identified a total of 7,971 unique individuals from photographs taken during close approaches. Of this total, 4,516 individuals were identified at wintering regions in at least one of the three seasons in which the study surveyed wintering areas and 4,328 individuals were identified at least once at feeding areas in one of the two years in which the study surveyed feeding areas. Based on the results of that effort, Calambokidis *et al.* (2008) estimated that the current population of humpback whales in the North Pacific Ocean consisted of about 18,300 whales, not counting calves. Almost half of the humpback whales that were estimated to occur in wintering areas, or about 8,000 humpback whales, occupy the Hawai’ian Islands during the winter months.

In the North Atlantic, Stevick *et al.* (2003) estimated the size of the humpback whale population between 1979 and 1993 by applying statistical analyses that are commonly used in capture-recapture studies to individual humpback whales that were identified based on natural markings. Between 1979 and 1993, they estimated that the North Atlantic populations (what they call the "West Indies breeding population") consisted of between 5,930 and 12,580 individual whales. The best estimate they produced (11,570; 95% confidence interval = 10,290 -13,390) was based on samples from 1992 and 1993. If we assume that this population has grown according to the instantaneous rate of increase Stevick *et al.* (2003) estimated for this population (r = 0.0311), this would lead us to estimate that this population might consist of about 18,400 individual whales in 2007-2008.

Regardless of which of these estimates, if any, most closely correspond to the actual size and trend of the humpback whale population, all of these estimates suggest that the global population of humpback whales consists of tens of thousands of individuals, that the North Atlantic population consists of at least 2,000 individuals and the North Pacific population consists of about 18,000 individuals. Based on ecological theory and demographic patterns derived from several hundred imperiled species and populations, humpback whales appear to exist at population sizes that are large enough to avoid demographic phenomena that are known to increase the extinction probability of species that exist as "small" populations (that is, "small" populations experience phenomena such as demographic stochasticity, inbreeding depression, and Allee effects, among others, that cause their population size to become a threat in and of itself). As a result, we assume that humpback whales will have elevated extinction probabilities because of exogenous threats caused by anthropogenic activities (primarily whaling, entanglement, and ship strikes) and natural phenomena (such as disease, predation, or changes in the distribution and abundance of their prey in response to changing climate) rather than endogenous threats caused by the small size of their population.

Diving and Social Behavior

In Hawai'ian waters, humpback whales remain almost exclusively within the 1820 m isobath and usually within waters depths less than 182 meters. Maximum diving depths are approximately 150 m (492 ft) (but usually <60 m [197 ft]), with a very deep dive (240 m [787 ft]) recorded off Bermuda (Hamilton *et al.* 1997). They may remain submerged for up to 21 min (Dolphin 1987). Dives on feeding grounds ranged from 2.1-5.1 min in the north Atlantic (Goodyear unpublished manuscript). In southeast Alaska average dive times were 2.8 min for feeding whales, 3.0 min for non-feeding whales, and 4.3 min for resting whales (Dolphin 1987). In the Gulf of California humpback whale dive times averaged 3.5 min (Strong 1989). Because most humpback prey is likely found above 300 m depths most humpback dives are probably relatively shallow.

In a review of the social behavior of humpback whales, Clapham (1986) reported that they form small, unstable social groups during the breeding season. During the feeding season they form small groups that occasionally aggregate on concentrations of food. Feeding groups are sometimes stable for long-periods of times. There is good evidence of some territoriality on feeding (Clapham 1994, 1996), and calving areas (Tyack 1981). 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 polygyny (Clapham 1996). Intermale competition for proximity to females can be intense as expected by the sex ratio on the breeding grounds which may be as high as 2.4:1.

Vocalizations and Hearing

Humpback whales produce at least three kinds of vocalization: (1) complex songs with components ranging from at least 20Hz B 4 kHz with estimated source levels from 144 B 174 dB, which are mostly produced by males on breeding areas (Payne 1970, Winn *et al.* 1970, Richardson *et al.* 1995); (2) social sounds in breeding areas that extend from 50 Hz B more than 10 kHz with most energy below 3 kHz (Tyack and Whitehead 1983, Richardson *et al.* 1995); and (3) vocalizations in foraging areas that are less frequent, but tend to be 20Hz B 2 kHz with estimated sources levels in excess of 175 dB re 1 μPa-m (Thompson *et al.* 1986, Richardson *et al.* 1995). Sounds that investigators associate with aggressive behavior in male humpback whales are very different from songs; they extend from 50 Hz to 10 kHz (or higher), with most energy in components below 3 kHz (Tyack 1983, Silber 1986). These sounds appear to have an effective range of up to 9 kilometers (Tyack and Whitehead 1983). A general description of the anatomy of the ear for cetaceans is provided in the description of the blue whale above; that description is also applicable to humpback whales.

In summary, humpback whales produce at least three kinds of sounds:

1. Complex songs with components ranging from at least 20 Hz–4 kHz with estimated source levels from 144 – 174 dB; these are mostly sung by males on the breeding grounds (Au et al 2006; Frazer and Mercado 2000; U.S. Navy 2006a; Payne 1970; Winn *et al.* 1970a; Richardson *et al.* 1995)

2. Social sounds in the breeding areas that extend from 50Hz – more than 10 kHz with most energy below 3 kHz (Tyack and Whitehead 1983, Richardson *et al.* 1995); and

3. Feeding area vocalizations that are less frequent, but tend to be 20 Hz–2 kHz with estimated sources levels in excess of 175 dB re 1 µPa-m (Thompson *et al.* 1986; Richardson *et al.* 1995).

Helwig *et al.* (2000) produced a mathematical model of a humpback whale's hearing sensitivity based on the anatomy of the whale's ear. Based on that model, they concluded that humpback whales would be sensitive to sound in frequencies ranging from 0.7kHz to 10kHz, with a maximum sensitivity between 2 and 6kHz.

3.7 North Atlantic Right Whale

Distribution

Right whales exist as three separate species: North Atlantic right whales (*Eubalaena glacialis*) that are distributed seasonally from the Gulf of Mexico north to waters off Newfoundland and Labrador (on the western Atlantic) and from northern Africa and Spain north to waters north of Scotland and Ireland (the Shetland and Orkney Islands; on the eastern Atlantic coast); North Pacific right whales (*E. japonica*) that historically ranged seasonally from the coast of Baja California north to the northern Bering Sea (on the eastern Pacific) and the south China Sea north to the Sea of Okhotsk and the Kamchatka Peninsula (on the western Pacific); and Southern right whales (*E. australis*) which historically ranged across the Southern Ocean, including waters off southern Australia, New Zealand, Chile, Argentina, and southern Africa (north to Madagascar).

In the western Atlantic Ocean, right whales generally occur in northwest Atlantic waters west of the Gulf Stream and are most commonly associated with cooler waters (21 C). 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*. 1990), and off Georgia and 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 the spring and summer months, and use mid-Atlantic waters as a migratory pathway between the winter calving grounds and their spring and summer nursery feeding areas in the Gulf of Maine. North Atlantic right whales are not found in the Caribbean Sea and have been recorded only rarely in the Gulf of Mexico.

Population Structure

NMFS recognizes two extant groups of right whales in the North Atlantic Ocean (*E. glacialis*): an eastern population and a western population. A third population may have existed in the central Atlantic (migrating from east of Greenland to the Azores or Bermuda), but appears to be extinct, if it existed as a distinct population at all (Perry *et al*. 1999).

The degree to which the two extant populations of North Atlantic right whales are connected through immigration or emigration is unknown, but the two populations have historically been treated as if they are isolated populations. Nevertheless, on 5 January 2009, a North Atlantic right whale that had been observed in the Bay of Fundy on 24 September 2008 was observed in the Azore Islands (38 22.698 N and 28 30.341W) which demonstrates that at least one right whale migrated across the Atlantic (L. Steiner, post on MarMam, 7 January 2009).

Threats to the Species

Natural threats. Several researchers have suggested that the recovery of right whales in the northern hemisphere 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 right whales overlapped with the foraging grounds of sei whales and both preferentially feed 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 right whale population in the North Atlantic 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.

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

Of the current threats to North Atlantic right whales, entanglement in commercial fishing gear and ship strikes currently pose the greatest threat to the persistence of North Atlantic right whales. Along the Atlantic Coast of the U.S. and the Maritime Provinces of Canada, there were 47 reports of right whales being entangled in fishing gear between 1999 and 2006 (Cole *et al*. 2005, Nelson *et al*. 2007, Glass *et al*. 2008). Of the 44 reports that NMFS could confirm, right whales were injured in 6 of the entanglements and killed in 5 entanglements.

In the same region, there were 21 reports of right whales being struck by vessels between 1999 and 2006 (Cole *et al*. 2005, Nelson *et al*. 2007, Glass *et al*. 2008). Of the reports that NMFS could confirm, right whales were injured in 3 of the ship strikes and killed in 31 ship strikes. In April 2009, a research vessel in the Stellwagen Bank National Marine Sanctuary struck a North Atlantic right whale while transiting to port. Pictures of the whale taken minutes after the stike revealed that the propeller had struck and cut the animal. Although the animal was injured the injury was deemed not life threatening.

The rate at which North Atlantic right whales are killed or injured by ship strikes and in entanglements also appears to be increasing over time: from 1999 to 2003, about 2.6 right whales were killed per year; from 2000 to 2004, about 2.8 right whales were killed per year; from 2001 to 2005, an average of 3.2 right whales were killed per year (NMFS 2005, NMFS 2006, Waring *et al*. 2007). The most recent estimate of anthropogenic mortality and serious injury available shows a rate of 3.8 right whales per year from 2002 to 2006. Of these, 2.4 were attributed to ship strikes and 1.4 were attributed to entanglements (Glass *et al*. 2008).

Status

Right whales (both *E. glacialis* and *E. australi*s) were listed as endangered under the ESA in 1970. In April, 2008, NMFS divided right whales into three separate listings: Northern right whales (*E. glacialis*), North Pacific right whales (*E. japonica*), and Southern right whales (*E. australis*), all of which were listed as endangered. Since 1949, the northern right whale has been protected from commercial whaling by the International Whaling Commission. They are also protected by the Convention on International Trade in Endangered Species of wild flora and fauna and the MMPA. NMFS designated critical habitat for the North Atlantic population of right whales on 3 June 1994 (59 FR 28793).

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 1993, Lande *et al*. 2003, Melbourne and Hastings 2008). Kraus *et al*. (2005) estimated that about 350 individual right whales, including about 70 mature females, occur in the western North Atlantic. Waring *et al*. (2008) reviewed the data from the recapture database and estimated that the right whale population in the western North Atlantic Ocean numbers about 325 whales.

At these population sizes, 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 thesephenomena 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 can leave 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). In general, an individual's contribution to the growth (or decline) of the population it represents depends, in part, on the number of individuals in the population: the smaller the population, the more the performance of a single individual is likely to affect the population‘s growth or decline (Coulson *et al*. 2006). Given the small size of the northern right whale population, the performance (“fitness” measured as the longevity of individuals and their reproductive success over their lifespan) of individual whales would be expected to have appreciable consequences for the growth or decline of the northern right whale population. Evidence of the small population dynamics of North Atlantic right whales appears in demographic models that suggest that the death or survival of one or two individual animals is sufficient to determine whether North Atlantic right whales are likely to accelerate or abate the rate at which their population continues to decline (Fujiwara and Caswell 2001).

These phenomena would increase the extinction probability of northern right whales and amplify the potential consequences of human-related activities on this species. Based on their population size and population ecology (that is, slow-growing mammals that give birth to single calves with several years between births), we assume that right whales would have elevated extinction probabilities because of exogenous threats caused by anthropogenic activities that result in the death or injury of individual whales (for example, ship strikes or entanglement) and natural phenomena (such as disease, predation, or changes in the distribution and abundance of their prey in response to changing climate) *as well as* endogenous threats resulting from the small size of their population. 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.

Diving and Social Behavior

Right whales dive as deep as 306 m (Mate *et al.* 1992). In the Great South Channel, average diving time is close to 2 minutes; average dive depth is 7.3 m with a maximum of 85.3 m (Winn *et al.* 1994). In the U.S. Outer Continental Shelf the average diving time is about 7 min although maximum dive durations are considerably longer (CeTAP 1982). For example, Baumgartner and Mate (2003) reported right whale feeding dives were characterized by a rapid descent from the surface to a particular depth between 80 and 175 m (262 to 574 ft) with animals remaining at those depths for 5 to 14 min, then ascending quickly to the surface (Baumgartner and Mate 2003). Longer surface intervals have been observed for reproductively active females and their calves (Baumgartner and Mate, 2003).

Northern right whales are primarily seen in groups of less than 12, most often singles or pairs (Jefferson *et al.* 1993). They may form larger groups while on feeding or breeding areas (Jefferson *et al.* 1993).

Vocalizations

North Atlantic right whales produce a variety of sounds, including moans, screams, gunshots, blows, upcalls, downcalls, and warbles that are often linked to specific behaviors (Matthews et al., 2001; Laurinolli et al., 2003; Vanderlaan et al., 2003; Parks et al., 2005; Parks and Tyack, 2005). Sounds can be divided into three main categories: (1) blow sounds; (2) broadband impulsive sounds; and (3) tonal call types (Parks and Clark, 2007). Blow sounds are those coinciding with an exhalation; it is not known whether these are intentional communication signals or just produced incidentally (Parks and Clark, 2007).

Broadband sounds include non-vocal slaps (when the whale strikes the surface of the water with parts of its body) and the”gunshot” sound; data suggests that the latter serves a communicative purpose (Parks and Clark, 2007). Tonal calls can be divided into simple, low-frequency, stereo-typed calls and more complex, frequency-modulated, higher-frequency calls (Parks and Clark 2007). Most of these sounds range in frequency from 0.02 to 15 kHz (dominant frequency range from 0.02 to less than 2 kHz; durations typically range from 0.01 to multiple seconds) with some sounds having multiple harmonics (Parks and Tyack 2005).

Source levels for some of these sounds have been measured as ranging from 137 to 192 dB root-mean-square (rms) re 1 Pa-m (decibels at the reference level of one micro Pascal at one meter) (Parks *et al*., 2005; Parks and Tyack, 2005). Parks and Clark (2005) suggested that the frequency of right whale vocalizations increases significantly during the period from dusk until dawn. Recent morphometric analyses of North Atlantic right whale inner ears estimates a hearing range of approximately 0.01 to 22 kHz based on established marine mammal models (Parks *et a*l. 2004, Parks and Tyack 2005, Parks *et al*. 2007). In addition, Parks *et al*. (2007) estimated the functional hearing range for right whales to be 15 Hz to 18 kHz.

3.8. Sei Whale

Distribution

Sei whales occur in every ocean except the Arctic Ocean. 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 the continental shelf edge (Hain *et al*. 1985); however, this general offshore pattern of sei whale distribution is disrupted during occasional incursions into more shallow and inshore waters (Waring *et al.* 2004).

In the western Atlantic Ocean, sei whales occur from Labrador, Nova Scotia,and Labrador in the summer months and migrate south to Florida, the Gulf of Mexico, and the northern Caribbean (Gambell 1985, Mead 1977). In the eastern Atlantic Ocean, sei whales occur in the Norwegian Sea (as far north as Finnmark in northeastern Norway), occasionally occurring as far north as Spitsbergen Island, and migrate south to Spain, Portugal, and northwest Africa (Jonsgård and Darling 1974, Gambell 1985).

In the North Pacific Ocean, sei whales occur from the Bering Sea south to California (on the east) and the coasts of Japan and Korea (on the west). During the winter, sei whales are found from 20°̣̃ 23°N (Masaki

1977; Gambell 1985). Horwood (1987) reported that 75 - 85% of the North Pacific population of sei whales resides east of 180° longitude.

Sei whales occur throughout the Southern Ocean during the summer months, although they do not migrate as far south to feed as blue or fin whales. During the austral winter, sei whales occur off Brazil and the western and eastern coasts of Southern Africa and Australia.

Population Structure

The population structure of sei whales is largely unknown because there are so few data on this species. The International Whaling Commission's Scientific Committee groups all of the sei whales in the entire North Pacific Ocean into one population (Donovan 1991). However, some mark-recapture, catch distribution, and morphological research suggest more than one "stock" of sei whales may exist in the Pacific: one between 175°W and 155°W longitude, and another east of 155°W longitude (Masaki 1977); however, the amount of movement between these "stocks" suggests that they probably do not represent demographically-isolated populations as we use this concept in this Opinion.

Mitchell and Chapman (1977) divided sei whales in the western North Atlantic in two populations, one that occupies the Nova Scotian Shelf and a second that occupies the Labrador Sea. Sei whales are most common on Georges Bank and into the Gulf of Maine and the Bay of Fundy during spring and summer, primarily in deeper waters. There are occasional influxes of sei whales further into Gulf of Maine waters, presumably in conjunction with years of high copepod abundance inshore. Sei whales are occasionally seen feeding in association with right whales in the southern Gulf of Maine and in the Bay of Fundy.

Threats to the Species

Natural threats. Sei whales appear to compete with blue, fin, and right whales for prey and that competition may limit the total abundance of each of the species (Rice 1974, Scarff 1986). As discussed previously in the narratives for fin and right whales, the foraging areas of right and sei whales in the western North Atlantic Ocean overlap and both whales feed preferentially on copepods (Mitchell 1975).

Anthropogenic threats. Two human activities are known to threaten sei whales: whaling and shipping. Historically, whaling represented the greatest threat to every population of sei whales and was ultimately responsible for listing sei whales as an endangered species. From 1910 to 1975, approximately 74,215 sei whales were caught in the entire North Pacific Ocean (Horwood 1987, Perry *et al.* 1999). From the early 1900s, Japanese whaling operations consisted of a large proportion of sei whales: 300 - 600 sei whales were killed per year from 1911 to 1955. The sei whale catch peaked in 1959, when 1,340 sei whales were killed. In 1971, after a decade of high sei whale catch numbers, sei whales were scarce in Japanese waters.

In the North Atlantic Ocean, sei whales were hunted from land stations in Norway and Iceland in the early- to mid-1880s, when blue whales started to become more scarce. In the late 1890s, whalers began hunting sei whales in Davis Strait and off the coasts of Newfoundland. In the early 1900s, whalers from land stations on the Outer Hebrides and Shetland Islands started to hunt sei whales. 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 sei whales (Mitchell and Chapman 1977).

Sei whales are occasionally killed in collisions with vessels. Of 3 sei whales that stranded along the Atlantic Coast of the U.S. between 1975 and 1996, 2 showed evidence of collisions with ships (Laist *et al.* 2001). Between 1999 and 2005, there were 3 reports of sei whales being struck by vessels along the Atlantic Coast of the U.S. and the Maritime Provinces of Canada (Cole *et al.* 2005, Nelson *et al.* 2007). Two of these ship strikes were reported as having resulted in the death of the sei whale.

Status

Sei whales were listed as endangered under the ESA in 1973. In the North Pacific, the International Whaling Commission began management of commercial taking of sei whales in 1970, and sei whales were given full protection in 1985 (Allen 1980). Sei whales are also protected by the Convention on International Trade in Endangered Species of wild flora and fauna and the Marine Mammal Protection Act. They are listed as endangered under the IUCN Red List of Threatened Animals (Baillie and Groombridge 1996). Critical habitat has not been designated for sei whales.

Prior to commercial whaling, sei whales in the north Pacific are estimated to have numbered 42,000 individuals (Tillman 1977), although Ohsumi and Fukuda (1975) estimated that sei whales in the north Pacific numbered about 49,000 whales in 1963, had been reduced to 37,000 or 38,000 whales by 1967, and reduced again to 20,600 to 23,700 whales by 1973. Japanese and Soviet catches of sei whales in the North Pacific and Bering Sea increased from 260 whales in 1962 to over 4,500 in 1968 and 1969, after which the sei whale population declined rapidly (Mizroch *et al.* 1984). When commercial whaling for sei whales ended in 1974, the population of sei whales in the North Pacific had been reduced to between 7,260 and 12,620 animals (Tillman 1977). In the same year, the north Atlantic population of sei whales was estimated to number about 2,078 individuals, including 965 whales in the Labrador Sea group and 870 whales in the Nova Scotia group (IWC 1977, Mitchell and Chapman 1977).

About 50 sei whales are estimated to occur in the North Pacific “stock” with another 77 sei whales in the Hawai’ian “stock” (Lowry *et al.* 2007). The abundance of sei whales in the Atlantic Ocean remains unknown (Lowry *et al.* 2007). In California waters, only one confirmed and five possible sei whale sightings were recorded during 1991, 1992, and 1993 aerial and ship surveys (Carretta and Forney 1993, Mangels and Gerrodette 1994). No sightings were confirmed off Washington and Oregon during recent aerial surveys. Several researchers have suggested that the recovery of right whales in the northern hemisphere has been slowed by other whales that compete with right whales for food. Mitchell (1975) analyzed trophic interactions among baleen whales in the western north Atlantic and noted that the foraging grounds of right whales overlapped with the foraging grounds of sei whales and both preferentially feed on copepods.

Like blue whales, the information available on the status and trend of sei whales do not allow us to reach any conclusions about the extinction risks facing sei whales as a species, or particular populations of sei whales. With the limited data available on sei whales, we do not know whether these whales exist at population sizes large enough to avoid demographic phenomena that are known to increase the extinction probability of species that exist as “small” populations (that is, “small” populations experience phenomena such as demographic stochasticity, inbreeding depression and Allee effects, among others, that cause their population size to become a threat in and of itself) or if sei whales are threatened more by exogenous threats such as anthropogenic activities (primarily whaling, entanglement, and ship strikes) or natural phenomena (such as disease, predation, or changes in the distribution and abundance of their prey in response to changing climate). However, sei whales have historically exhibited sudden increases in abundance in particular areas followed by sudden decreases in number. Several authors have reported “invasion years” in which large numbers of sei whales appeared off areas like Norway and Scotland, followed the next year by sudden decreases in population numbers (Jonsgård and Darling 1974).

With the evidence available, we do not know if this year-to-year variation still occurs in sei whales. However, if sei whales exist as a fraction of their historic population sizes, large amounts of variation in their abundance would increase the extinction probabilities of individual populations (Fagan and Holmes 2006, Fagan *et al.* 1999, 2001).

Diving and Social Behavior

Generally, sei whales make 5-20 shallow dives of 20-30 sec duration followed by a deep dive of up to 15 min (Gambell 1985). The depths of sei whale dives have not been studied, however the composition of their diet suggests that they do not perform dives in excess of 300 meters. Sei whales are usually found in small groups of up to 6 individuals, but they commonly form larger groupings when they are on feeding grounds (Gambell 1985).

Vocalizations and Hearing

There is a limited amount of information on the vocal behavior of sei whales. McDonald et al. (2005) recorded sei whale vocalizations off the Antarctic Peninsula that included broadband sounds in the 100-600 Hz range with 1.5 second duration and tonal and upsweep call in the 200-600 Hz range 1-3 second duration. During visual and acoustic surveys conducted in the Hawaiʻian Islands in 2002, Rankin and Barlow (2007) recorded 107 sei whale vocalizations, which they classified as two variations of low-frequency downswept calls. The first variation consisted of sweeps from 100 Hz to 44 Hz, over 1.0 seconds. 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.

A general description of the anatomy of the ear for cetaceans is provided in the preceding description of the blue whale.

3.9. Sperm Whale

Distribution

Sperm whales occur in every ocean except the Arctic Ocean. Sperm whales are found throughout the North Pacific and are distributed broadly from tropical and temperate waters to the Bering Sea as far north as Cape Navarin. Mature, female, and immature sperm whales of both sexes are found in more temperate and tropical waters from the equator to around 45˚ N throughout the year. These groups of adult females and immature sperm whales are rarely found at latitudes higher than 50˚ N and 50˚ S (Reeves and Whitehead 1997). Sexually mature males join these groups throughout the winter. During the summer, mature male sperm whales are thought to move north into the Aleutian Islands, Gulf of Alaska, and the Bering Sea.

In the western Atlantic Ocean, sperm whales are distributed in a distinct seasonal cycle, concentrated 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 Ocean, mature male sperm whales have been recorded as far north as Spitsbergen (Oien, 1990). Recent observations of sperm whales and stranding events involving sperm whales from the eastern North Atlantic suggest that solitary and paired mature male sperm whales predominantly occur in waters off Iceland, the Faroe Islands, and the Norwegian Sea (Gunnlaugsson and Sigurjonsson 1990, Oien 1990, Christensen *et al.* 1992).

In the Mediterranean Sea sperm whales are found from the Alboran Sea to the Levant Basin, mostly over steep slope and deep offshore waters. Sperm whales are rarely sighted in the Sicilian Channel, and are vagrant in the northern Adriatic and Aegean Seas (Notarbartolo di Sciara and Demma 1997). In the Italian seas sperm whales are more frequently associated with the continental slope off western Liguria, western Sardinia, northern and eastern Sicily, and both coasts of Calabria.

Sperm whales are found throughout the North Pacific and are distributed broadly from tropical and temperate waters to the Bering Sea as far north as Cape Navarin. Mature female and immature sperm whales of both sexes are found in more temperate and tropical waters from the equator to around 45°N throughout the year. However, groups of adult females and immature sperm whales are rarely found at latitudes higher than 50°N and 50°S (Reeves and Whitehead 1997). Sexually mature males join these groups throughout the winter. During the summer, mature male sperm whales are thought to migrate into the Aleutian Islands, Gulf of Alaska, and the Bering Sea.

Sperm whales commonly concentrate around oceanic islands in areas of upwelling, and along the outer continental shelf and mid-ocean waters. Because they inhabit deeper pelagic waters, their distribution does not include the broad continental shelf of the Eastern Bering Sea and these whales generally remain offshore in the eastern Aleutian Islands, Gulf of Alaska, and the Bering Sea.

Sperm whales have a strong preference for the 3,280 feet (1,000 meters) depth contour and seaward. Berzin (1971) reported that they are restricted to waters deeper than 300 meters (984 feet), while Watkins (1977) and Reeves and Whitehead (1997) reported that they are usually not found in waters less than 1,000 meters (3,281 feet) deep. While deep water is their typical habitat, sperm whales have been observed near Long Island, New York, in water between 41-55 meters (135-180 feet; Scott and Sadove 1997). When they are found relatively close to shore, sperm whales are usually associated with sharp increases in bottom depth where upwelling occurs and biological production is high, implying the presence of a good food supply (Clarke 1956).

Population Structure

The population structure of sperm whales is largely unknown. Lyrholm and Gyllenstein (1998) reported moderate, but statistically significant, differences in sperm whale mitochondrial (mtDNA) between ocean basins, although sperm whales throughout the world appear to be homogenous genetically (Whitehead 2003). Genetic studies also suggest that sperm whales of both genders commonly move across over ocean basins and that males, but not females, often breed in ocean basins that are different from the one in which they were born (Whitehead, 2003).

Sperm whales may not form “populations” as that term is normally conceived. Jaquet (1996) outlined a hierarchical social and spatial structure that includes temporary clusters of animals, family units of 10 or 12 females and their young, groups of about 20 animals that remain together for hours or days, “aggregations” and “super-aggregations” of 40 or more whales, and “concentrations” that include 1,000 or more animals (Peterson 1986, Whitehead and Wiegart 1990, Whitehead *et al.* 1991). The “family unit” forms the foundation for sperm whale society and most females probably spend their entire life in the same family unit (Whitehead 2002). The dynamic nature of these relationships and the large spatial areas they are believed to occupy might complicate or preclude attempts to apply traditional population concepts, which tend to rely on group fidelity to geographic distributions that are relatively static over time.

Atlantic Ocean

Based on harvests of tagged sperm whales or sperm whales with other distinctive marking, sperm whales in the North Atlantic Ocean appear to represent a single population, with the possible exception of the sperm whales that appear to reside in the Gulf of Mexico. Mitchell (1975) reported one sperm whale that was tagged on the Scotian Shelf and killed about 7 years later off Spain. Donovan (1991) reported five to six handheld harpoons from the Azore sperm whale fishery that were recovered from whales killed off northwest Spain, with another Azorean harpoon recovered from a male sperm whale killed off Iceland (Martin 1982). These patterns suggest that at least some sperm whales migrate across the North Atlantic Ocean.

Female and immature animals stay in Atlantic temperate or tropical waters year round. In the western North Atlantic, groups of female and immature sperm whales concentrate in the Caribbean Sea (Gosho *et al.* 1984) and south of New England in continental-slope and deep-ocean waters along the eastern United States (Blaylock *et al.* 1995). In eastern Atlantic waters, groups of female and immature sperm whales aggregate in waters off the Azores, Madeira, Canary, and Cape Verde Islands (Tomilin 1967).

Several investigators have suggested that the sperm whales that occupy the northern Gulf of Mexico are distinct from sperm whales elsewhere in the North Atlantic Ocean (Schmidly 1981, Fritts 1983, and Hansen *et al.* 1995), although the International Whaling Commission groups does not treat these sperm whales as a separate population or "stock."

In the Mediterranean Sea sperm whales are found from the Alboran Sea to the Levant Basin, mostly over steep slope and deep offshore waters. Sperm whales are rarely sighted in the Sicilian Channel, and are vagrant in the northern Adriatic and Aegean Seas (Notarbartolo di Sciara and Demma 1997). In the Italian seas sperm whales are more frequently associated with the continental slope off western Liguria, western Sardinia, northern and eastern Sicily, and both coasts of Calabria.

Bayed and Beaubrun (1987) suggested that the frequent observation of neonates in the Mediterranean Sea and the scarcity of sperm whale sightings from the Gibraltar area may be evidence of a resident population of sperm whales in the Mediterranean.

Gulf of Mexico

Several investigators have suggested that the sperm whales that occupy the northern Gulf of Mexico are distinct from sperm whales elsewhere in the North Atlantic Ocean based on year-round presence in the

Gulf (Schmidly 1981, Fritts 1983, and Hansen et al. 1996, Mullin and Hoggard 2000). More recent studies provide further support that Gulf of Mexico sperm whales are a separate stock based on year round presence in the Gulf and preliminary results of genetics, size distribution and coda vocalizations (Mullin *et al.* 2003, Jaquet 2006; Jochens *et al.* 2008). These studies, like almost all studies to date, rely almost exclusively on sperm whales from the northern Gulf, with greatest density along and deeper than the 1000 m depth contour, and do not adequately represent sperm whales that may occur regularly in the central, western, southern, or eastern Gulf (for example, Ortega-Ortiz 2003). It is very likely, though, that sperm whales of the north-central Gulf, present there throughout the year (Davis et al. 1998), are more numerous than in other parts of the Gulf (Jochens *et al* 2008). Based on this information NMFS provisionally considers the sperm whale population in the northern Gulf of Mexico as a separate stock, however, the IWC, does not recognize these sperm whales as a separate stock.

Indian Ocean

In the Northern Indian Ocean the International Whaling Commission recognized differences between sperm whales in the northern and southern Indian Ocean (Donovan 1991). Little is known about the Northern Indian Ocean population of sperm whales (Perry *et al.* 1999).

Pacific Ocean

Several authors have proposed population structures that recognize at least three sperm whales populations in the North Pacific for management purposes (Kasuya 1991, Bannister and Mitchell 1980). At the same time, the IWC's Scientific Committee designated two sperm whale stocks in the North Pacific: a western and eastern stock or population (Donovan 1991). The line separating these populations has been debated since their acceptance by the IWC's Scientific Committee. For stock assessment purposes, NMFS recognizes three discrete population centers of sperm whales in the Pacific: (1) Alaska, (2) California-Oregon-Washington, and (3) Hawai'i.

Sperm whales are widely distributed throughout the Hawai'ian Islands throughout the year and are the most abundant large whale in waters off Hawai'i during the summer and fall (Rice 1960, Shallenberger 1981, Lee 1993, and Mobley *et al.* 2000). Sperm whale clicks recorded from hydrophones off Oahu confirm the presence of sperm whales near the Hawai'ian Islands throughout the year (Thompson and Friedl 1982). The primary area of occurrence for the sperm whale is seaward of the shelf break in the Hawai'ian Islands.

Sperm whales have been sighted in the Kauai Channel, the Alenuihaha Channel between Maui and the island of Hawai'i, and off the island of Hawai'i (Lee 1993, Mobley *et al.*1999, Forney *et al.* 2000). Additionally, the sounds of sperm whales have been recorded throughout the year off Oahu (Thompson and Friedl 1982). Twenty-one sperm whales were sighted during aerial surveys conducted in Hawai'ian waters conducted from 1993 through 1998. Sperm whales sighted during the survey tended to be on the outer edge of a 50 - 70 km distance from the Hawai'ian Islands, indicating that presence may increase with distance from shore. However, from the results of these surveys, NMFS has calculated a minimum abundance of sperm whales within 46 km of Hawai'i to be 43 individuals (Forney *et al.* 2000).

Southern Ocean

Sperm whales south of the equator are generally treated as a single "population," although the International Whaling Commission divides these whales into nine different divisions that are based more on evaluations of whaling captures than the biology of sperm whales (Donovan 1991). Several authors, however, have argued that the sperm whales that occur off the Galapagos Islands, mainland Ecuador, and northern Peru are geographically distinct from other sperm whales in the Southern Hemisphere (Rice 1977, Wade and Gerrodette 1993, and Dufault and Whitehead 1995).

Threats to the Species

Natural threats. Sperm whales are hunted by killer whales (*Orcinus orca*), false killer whales (*Pseudorca crassidens*), and short-finned pilot whales (*Globicephala melas*; Arnbom *et al.* 1987, Palacios and Mate 1996, Rice 1989, Weller *et al.* 1996, Whitehead 1995). Sperm whales have been observed with bleeding wounds on their heads and tail flukes after attacks by these species (Arnbom *et al.* 1987, Dufault and Whitehead 1995). In October 1997, 25 killer whales were documented to have attacked a group of mature sperm whales off Point Conception, California (personal communication from K Roberts cited in Perry *et al.* 1999) and successfully killed one of these mature sperm whales.

Studies on sperm whales in the North Pacific and North Atlantic Oceans have demonstrated that sperm whales are infected by caliciviruses and papillomavirus (Smith and Latham 1978, Lambertsen *et al.* 1987). In some instances, these diseases have been demonstrated to affect 10 percent of the sperm whales sampled (Lambertsen *et al.* 1987).

Anthropogenic threats. Three human activities are known to threaten sperm whales: whaling, entanglement in fishing gear, and shipping. Historically, whaling represented the greatest threat to every population of sperm whales and was ultimately responsible for listing sperm whales as an endangered species. Sperm whales were hunted all over the world during the 1800s, largely for spermaceti oil and ambergris. Harvesting of sperm whales subsided by 1880 when petroleum replaced the need for sperm whale oil (Whitehead 2003).

The actual number of sperm whales killed by whalers remains unknown and some of the estimates of harvest numbers are contradictory. Between 1800 and 1900, the International Whaling Commission estimated that nearly 250,000 sperm whales were killed globally by whalers. From 1910 to 1982, another 700,000 sperm whales were killed globally by whalers (IWC Statistics 1959-1983). These estimates are substantially higher than a more recent estimate produced by Caretta *et al.* (2005), however, who estimated that at least 436,000 sperm whales were killed by whalers between 1800 and 1987. Hill and DeMaster (1999) concluded that about 258,000 sperm whales were harvested in the North Pacific between 1947 and 1987 by commercial whalers. They reported that catches in the North Pacific increased until 1968, when 16,357 sperm whales were harvested, then declined after 1968 because of harvest limits imposed by the IWC. Perry *et al.* (1999) estimated that, on average, more than 20,000 sperm whales were harvested in the Southern Hemisphere each year between 1956 and 1976.

These reports probably underestimate the actual number of sperm whales that were killed by whalers, particularly because they could not have incorporated realistic estimates of the number of sperm whales killed by Soviet whaling fleets, which often went unreported. Between 1947 and 1973, Soviet whaling fleets engaged in illegal whaling in the Indian, North Pacific, and southern Oceans. In the Southern Hemisphere, these whalers killed an estimated 100,000 whales that they did not report to the International Whaling Commission (Yablokov *et al.* 1998). Illegal catches in the Northern Hemisphere (primarily in the North Pacific) were smaller but still caused sperm whales to disappear from large areas of the North Pacific Ocean (Yablokov and Zemsky 2000).

In addition to large and illegal harvests of sperm whales, Soviet whalers had disproportionate effect on sperm whale populations because they commonly killed adult females in any reproductive condition (pregnant or lactating) as well as immature sperm whales of either gender.

When the International Whaling Commission introduced the International Observer Scheme in 1972, the IWC relaxed regulations that limited the minimum length of sperm whales that could be caught from 11.6 meters to 9.2 meters out of a concern that too many male sperm whales were being caught so reducing this size limit would encourage fleets to catch more females. Unfortunately, the IWC's decision had been based on data from the Soviet fleets who commonly reported female sperm whales as males. As a result, the new regulations allowed the Soviet whalers to continue their harvests of female and immature sperm whales legally, with substantial consequences for sperm whale populations. Berzin noted in a report he wrote in 1977, "the result of this was that some breeding areas for sperm whales became deserts" (Berzin 2007).

Although the International Whaling Commission protected sperm whales from commercial harvest in 1981, whaling operations along the Japanese coast continued to hunt sperm whales in the North Pacific until 1988 (Reeves and Whitehead 1997). More recently, the Japanese Whaling Association began hunting sperm whales for research. In 2000, the Japanese Whaling Association announced that it planned to kill 10 sperm whales in the Pacific Ocean for research, which was the first time sperm whales have been hunted since the international ban on commercial whaling. Despite protests from the U.S. government and members of the IWC, the Japanese government harvested 5 sperm whales and 43 Bryde's whales in the last six months of 2000. According to the Japanese Institute of Cetacean Research (Institute of Cetacean Research undated), another 5 sperm whales were killed for research in 2002 – 2003. The consequences of these deaths on the status and trend of sperm whales remains uncertain, given that they probably have not recovered from the legacy of whaling; however, the renewal of a program that intentionally targets and kills sperm whales before we can be certain they recovered from a history of over-harvest places this species at risk in the foreseeable future.

Sperm whales are still hunted for subsistence purposes by whalers from Lamalera, Indonesia, which is on the south coast of the island of Lembata and from Lamakera on the islands of Solor. These whalers hunt in a traditional manner: with bamboo spears and using small wooden outriggers, 10–12 m long and 2 m wide, constructed without nails and with sails woven from palm fronds. The animals are killed by the harpooner leaping onto the back of the animal from the boat to drive in the harpoon. The maximum number of sperm whales killed by these hunters in any given year was 56 sperm whales killed in 1969.

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 (Rice 1989, Hill and DeMaster 1999). 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.

Sperm whales are also killed by ship strikes. In May 1994 a sperm whale that had been struck by a ship was observed south of Nova Scotia (Reeves and Whitehead 1997) and in May 2000 a merchant ship reported a strike in Block Canyon (nmfs, unpublished data), which is a major pathway for sperm whales entering southern New England continental shelf waters in pursuit of migrating squid (CeTAP 1982, Scott and Sadove 1997).

Status

Sperm whales were listed as endangered under the ESA in 1973. Sperm whales have been protected from commercial harvest by the International Whaling Commission since 1981, although the Japanese continued to harvest sperm whales in the North Pacific until 1988 (Reeves and Whitehead 1997). They are also protected by the Convention on International Trade in Endangered Species of Wild Flora and Fauna and the MMPA. Critical habitat has not been designated for sperm whales.

The status and trend of sperm whales at the time of this summary is largely unknown. Hill and DeMaster (1999) and Angliss and Lodge (2004) reported that estimates for population abundance, status, and trends for sperm whales off the coast of Alaska were not available when they prepared the Stock Assessment Report for marine mammals off Alaska. Similarly, no information was available to support estimates of sperm whales status and trends in the western North Atlantic Ocean (Waring *et al.* 2004), the Indian Ocean (Perry *et al.* 1999), or the Mediterranean Sea.

Nevertheless, several authors and organizations have published "best estimates" of the global abundance of sperm whales or their abundance in different geographic areas. Based on historic whaling data,190,000 sperm whales were estimated to have been in the entire North Atlantic, but the IWC considers data that produced this estimate unreliable (Perry *et al.* 1999). Whitehead (2002) estimated that prior to whaling sperm whales numbered around 1,110,000 and that the current global abundance of sperm whales is around 360,000 (coefficient of variation = 0.36) whales. Whitehead's current population estimate (2002) is about 20% of past global abundance estimates which were based on historic whaling data.

Waring *et al.* (2007) concluded that the best estimate of the number of sperm whales along the Atlantic coast of the U.S. was 4,029 (coefficient of variation = 0.38) in 1998 and 4,804 (coefficient of variation = 0.38) in 2004, with a minimum estimate of 3,539 sperm whales in the western North Atlantic Ocean.

Barlow and Taylor (2005) derived two estimates of sperm whale abundance in a 7.8 million km^2 study area in the northeastern temperate Pacific: when they used acoustic detection methods they produced an estimate of 32,100 sperm whales (coefficient of variation = 0.36); when they used visual surveys, they produced an estimate of 26,300 sperm whales (coefficient of variation = 0.81). Caretta *et al.* (2005) concluded that the most precise estimate of sperm whale abundance off California, Oregon, and Washington was 1,233 (coefficient of variation = 0.41; based on ship surveys conducted in the summer and fall of 1996 and 2001). Their best estimate of the abundance of sperm whales in Hawai'i was 7,082 sperm whales (coefficient of variation = 0.30) based on ship-board surveys conducted in 2002.

Mark and recapture data from sperm whales led Whitehead and his co-workers to conclude that sperm whale numbers off the Galapagos Islands decreased by about 20% a year between 1985 and 1995 (Whitehead *et al.* 1997). In 1985 Whitehead *et al.* (1997) estimated there were about 4,000 female and immature sperm whales, whereas in 1995 they estimated that there were only a few hundred. They suggested that sperm whales migrated to waters off the Central and South American mainland to feed in productive waters of the Humboldt Current, which had been depopulated of sperm whales as a result of intensive whaling.

The information available on the status and trend of sperm whales do not allow us to make a definitive statement about the extinction risks facing sperm whales as a species or particular populations of sperm whales. However, the evidence available suggests that sperm whale populations probably exhibit the dynamics of small populations, causing their population dynamics to become a threat in and of itself. The number of sperm whales killed by Soviet whaling fleets in the 1960s and 1970s would have substantial and adverse consequence for sperm whale populations and their ability to recover from the effects of whaling on their population. The number of adult females killed by Soviet whaling fleets, including pregnant and lactating females whose death would also have resulted in the death of their calves, would have had a devastating effect on sperm whale populations. In addition to decimating their population size, whaling would have skewed sex ratios in their populations, created gaps in the age structure of their populations, and would have had lasting and adverse effect on the ability of these populations to recover (for example, see Whitehead 2003).

Populations of sperm whales could not have recovered from the overharvests of adult females and immature whales in the 30 to 40 years that have passed since the end of whaling, but the information available does not allow us to determine whether and to what degree those populations might have stabilized or whether they have begun the process of recovering from the effects of whaling. Absent information to the contrary, we assume that sperm whales will have elevated extinction probabilities because of both exogenous threats caused by anthropogenic activities (primarily whaling, entanglement, and ship strikes) and natural phenomena (such as disease, predation, or changes in the distribution and abundance of their prey in response to changing climate) as well as endogenous threats caused by the legacy of overharvests of adult females and immature whales on their populations (that is, a population with a disproportion of adult males and older animals coupled with a small percentage of juvenile whales that recruit into the adult population).

Diving and Social Behavior

Sperm whales are probably the deepest and longest diving mammal: they can dive to depths of at least 2000 meters (6562 ft), and may remain submerged for an hour or more (Watkins *et al.* 1993). Typical foraging dives last 40 min and descend to about 400 m followed by about 8 min of resting at the surface (Gordon 1987; Papastavrou *et al.* 1989). However, dives of over 2 hr and as deep as 3,000 m have been recorded (Clarke 1976; Watkins *et al.* 1985). Descent rates recorded from echo-sounders were approximately 1.7m/sec and nearly vertical (Goold and Jones 1995). There are no data on diurnal differences in dive depths in sperm whales. However, like most diving vertebrates for which there are data (e.g. rorqual whales, fur seals, chinstrap penguins), sperm whales probably make relatively shallow dives at night when organisms from the ocean's deep scattering layers move toward the ocean's surface.

The groups of closely related females and their offspring develop dialects specific to the group (Weilgart and Whitehead 1997) and females other than birth mothers will guard young at the surface (Whitehead 1996) and will nurse young calves (Reeves and Whitehead 1997).

Vocalizations and Hearing

Sperm whales produce loud broad-band clicks from about 0.1 to 20 kHz (Weilgart and Whitehead 1993, 1997; Goold and Jones 1995). These have source levels estimated at 171 dB re 1 μPa (Levenson 1974). Current evidence suggests that the disproportionately large head of the sperm whale is an adaptation to produce these vocalizations (Norris and Harvey 1972; Cranford 1992; but see Clarke 1979). This suggests that the production of these loud low frequency clicks is extremely important to the survival of individual sperm whales. The function of these vocalizations is relatively well-studied (Weilgart and Whitehead 1993, 1997; Goold and Jones 1995). Long series of monotonous regularly spaced clicks are associated with feeding and are thought to be produced for echolocation. Distinctive, short, patterned series of clicks, called codas, are associated with social behavior and intragroup interactions; they are thought to facilitate intra-specific communication, perhaps to maintain social cohesion with the group (Weilgart and Whitehead 1993).

A general description of the anatomy of the ear for cetaceans is provided in the description of the blue whale above. The only data on the hearing range of sperm whales are evoked potentials from a stranded neonate (Carder and Ridgway 1990). These data suggest that neonatal sperm whales respond to sounds from 2.5-60 kHz. Sperm whales have been observed to frequently stop echolocating in the presence of underwater pulses made by echosounders and submarine sonar (Watkins and Schevill 1975; Watkins *et al.* 1985). 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). Sperm whales have moved out of areas after the start of air gun seismic testing (Davis *et al.* 1995). Seismic air guns produce loud, broadband, impulsive noise (source levels are on the order of 250 dB) with “shots” every 15 seconds, 240 shots per hour, 24 hours per day during active tests. 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* 1999). Furthermore, because of their apparent role as important predators of mesopelagic squid and fish, changing the abundance of sperm whales should affect the distribution and abundance of other marine species.

3.10. Green Sea Turtle

Distribution

Green turtles are found in the Pacific Ocean, Atlantic Ocean, Indian Ocean, Caribbean Sea, and Mediterranean Sea, primarily in tropical or, to a lesser extent, subtropical waters. These regions can be further divided into nesting aggregations within the eastern, central, and western Pacific Ocean; the western, northern, and eastern Indian Ocean; Mediterranean Sea; and eastern, southern, and western Atlantic Ocean, including the Caribbean Sea.

Green turtles appear to prefer waters that usually remain around 20^{o}C in the coldest month. During warm spells (e.g., El Niño), green turtles may be found considerably north of their normal distribution. Stinson (1984) found green turtles appear most frequently in U.S. coastal waters with temperatures exceeding 18°C. An east Pacific green turtle equipped with a satellite transmitter was tracked along the California coast and showed a distinct preference for waters with temperatures above 20°C (Eckert, unpublished data).

Further, green sea turtles seem to occur preferentially in drift lines or surface current convergences, probably because of the prevalence of cover and higher densities of their food items associated with these oceanic phenomena. For example, in the western Atlantic Ocean, drift lines commonly contain floating *Sargassum* capable of providing small turtles with shelter and sufficient buoyancy to raft upon (NMFS and USFWS 1998a). Underwater resting sites include coral recesses, the underside of ledges, and sand bottom areas that are relatively free of strong currents and disturbance from natural predators and humans. Available information indicates that green turtle resting areas are in proximity to their feeding pastures (NMFS 2000).

Population Structure

The population dynamics of green sea turtles and all of the other sea turtles we consider here are usually described based on the distribution and habit of nesting females, rather than their male counterparts. The spatial structure of male sea turtles and their fidelity to specific coastal areas is unknown; however, we describe sea turtle populations based on the nesting beaches that female sea turtles return to when they mature. Because the patterns of increase or decrease in the abundance of sea turtle nests over time are determined by internal dynamics rather than external dynamics, we make inferences about the growth or decline of sea turtle populations based on the status and trend of their nests.

Primary nesting aggregations of green turtles (i.e. sites with greater than 500 nesting females per year) include: Ascension Island (south Atlantic Ocean), Australia, Brazil, Comoros Islands, Costa Rica, Ecuador (Galapagos Archipelago), Equatorial Guinea (Bioko Island), Guinea-Bissau (Bijagos Archipelago), Iles Eparses Islands (Tromelin Island, Europa Island), Indonesia, Malaysia, Myanmar, Oman, Philippines, Saudi Arabia, Seychelles Islands, Suriname, and United States (Florida; Seminoff 2002, NMFS and USFWS 1998a).

Smaller nesting aggregations include: Angola, Bangladesh, Bikar Atoll, Brazil, Chagos Archipelago, China, Costa Rica, Cuba, Cyprus, Democratic Republic of Yemen, Dominican Republic, d'Entrecasteaux Reef, French Guiana, Ghana, Guyana, India, Iran, Japan, Kenya, Madagascar, Maldives Islands, Mayotte Archipelago, Mexico, Micronesia, Pakistan, Palmerston Atoll, Papua New Guinea, Primieras Islands, Sao Tome é Principe, Sierra Leone, Solomon Islands, Somalia, Sri Lanka, Taiwan, Tanzania, Thailand, Turkey, Scilly Atoll, United States (Hawai'i), Venezuela, and Vietnam (Seminoff 2002).

Molecular genetics techniques have helped researchers gain insight into the distribution and ecology of migrating and nesting green turtles. In the Pacific Ocean, green sea turtles group into two distinct regional clades: (1) western Pacific and South Pacific islands, and (2) eastern Pacific and central Pacific, including the rookery at French Frigate Shoals, Hawai'i. In the eastern Pacific, greens forage coastally from San Diego Bay, California in the north to Mejillones, Chile in the South. Based on mtDNA analyses, green turtles found on foraging grounds along Chile's coast originate from the Galapagos nesting beaches, while those greens foraging in the Gulf of California originate primarily from the

Michoacan nesting stock. 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).

Threats to the Species

Natural Threats. The various habitat types green sea turtles occupy throughout their lives exposes these sea turtles to a wide variety of natural threats. The beaches on which green sea turtles nest and the nests themselves are threatened by hurricanes and tropical storms as well as the storm surges, sand accretion, and rainfall that are associated with hurricanes. Hatchlings are hunted by predators like herons, gulls, dogfish, and sharks. Larger green sea turtles, including adults, are also killed by sharks and other large, marine predators.

Green turtles in the northwest Hawai'ian Islands are afflicted with a tumor disease, fibropapilloma, which is of an unknown etiology and often fatal, as well as spirochidiasis, both of which are the major causes of strandings of this species. The presence of fibropapillomatosis among stranded turtles has increased significantly over the past 17 years, ranging from 47-69 percent during the past decade (Murakawa *et al.* 2000). Green turtles captured off Molokai from 1982-96 showed a massive increase in the disease over this period, peaking at 61% prevalence in 1995 (Balazs *et al.* 1998). Preliminary evidence suggests an association between the distribution of fibropapillomatosis in the Hawai'ian Islands and the distribution of toxic benthic dinoflagellates (*Prorocentrum* spp.) known to produce a tumor promoter, okadaic acid (Landsberg *et al.* 1999). Fibropapillomatosis is considered to decrease growth rates in afflicted turtles and may inhibit the growth rate of Hawai'ian green turtle populations (Balazs *et al.* 1998).

Anthropogenic Threats. Three human activities are known to threaten green sea turtles: overharvests of individual animals, incidental capture in commercial fisheries, and human development of coastlines. Historically, the primary cause of the global decline of green sea turtles populations were the number of eggs and adults captured and killed on nesting beaches in combination with the number of juveniles and adults captured and killed in coastal feeding areas. Some populations of green sea turtles still lose large numbers of eggs, juveniles, and adults to subsistence hunters, local communities that have a tradition of harvesting sea turtles, and poachers in search of turtle eggs and meat.

Directed harvests of eggs and other life stages of green sea turtles were identified as a "major problem" in American Samoa, Guam, Palau, Commonwealth of the Northern Mariana Islands, Federated States of Micronesia, Republic of the Marshall Islands, and the Unincorporated Islands (Wake, Johnston, Kingman, Palmyra, Jarvis, Howland, Baker, and Midway). 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 (Bräutigam and Eckert 2006); the turtle fishery along the Caribbean coast of Nicaragua has captured more than 11,000 green sea turtles each year for the past 10 years (Bräutigam and Eckert 2006, Lagueux 1998).

Severe overharvests have resulted from a number of factors in modern times: (1) the loss of traditional restrictions limiting the number of turtles taken by island residents; (2) modernized hunting gear; (3) easier boat access to remote islands; (4) extensive commercial exploitation for turtle products in both domestic markets and international trade; (5) loss of the spiritual significance of turtles; (6) inadequate regulations; and (7) lack of enforcement (NMFS and USFWS 1998a).

Green sea turtles are also captured and killed in commercial fisheries. Gillnets account for the highest number of green sea turtles that are captured and killed, but they are also captured and killed in trawls, traps and pots, longlines, and dredges. Along the Atlantic coast of the U.S., NMFS estimated that almost 19,000 green sea turtles are captured in shrimp trawl fisheries each year in the Gulf of Mexico, with 514 of those sea turtles dying as a result of their capture (see Table 8). Each year, several hundred green sea turtles are captured in herring fisheries; mackerel, squid, and butterfish fisheries; monkfish fisheries; pound net fisheries, summer flounder and scup fisheries; Atlantic pelagic longline fisheries; and gillnet fisheries in Pamlico Sound. Although most of these turtles are released alive, these fisheries are expected to kill almost 100 green sea turtles each year; the health effects of being captured on the sea turtles that survive remain unknown.

Green sea turtles are also threatened by domestic or domesticated animals which prey on their nests; artificial lighting that disorients adult female and hatchling sea turtles, which can dramatically increase the mortality rates of hatchling sea turtles; beach replenishment; ingestion and entanglement in marine debris; and environmental contaminants.

Status

Green turtles are listed as threatened under the ESA, except for breeding populations found in Florida and the Pacific coast of Mexico, which are listed as endangered. Seminoff (2002) estimates using a conservative approach that the global green turtle population has declined by 34% to 58% over the last three generations (approximately 150 years). Actual declines may be closer to 70% to 80%. Causes for this decline include harvest of eggs, subadults and adults, incidental capture by fisheries, loss of habitat, and disease.

While some nesting populations of green turtles appear to be stable or increasing in the Atlantic Ocean (e.g. Bujigos Archipelago (Guinea-Bissau), Ascension Island, Tortuguero (Costa Rica), Yucatan Peninsula (Mexico), and Florida), declines of over 50% have been documented in the eastern (Bioko Island, Equatorial Guinea) and western Atlantic (Aves Island, Venezuela). Nesting populations in Turkey (Mediterranean Sea) have declined between 42% and 88% since the late 1970s. Population trend variations also appear in the Indian Ocean. Declines greater than 50% have been documented at Sharma (Republic of Yemen) and Assumption and Aldabra (Seychelles), while no changes have occurred at Karan Island (Saudi Arabia) or at Ras al Hadd (Oman). The number of females nesting annually in the

Indian Ocean has increased at the Comoros Islands, Tromelin and maybe Europa Island (Iles Esparses; Seminoff 2002).

Green turtles are thought to be declining throughout the Pacific Ocean, with the exception of Hawai'i, as a direct consequence of a historical combination of overexploitation and habitat loss (Eckert 1993, Seminoff 2002). They are also thought to be declining in the Atlantic Ocean. However, like several of the species we have already discussed, the information available on the status and trend of green sea turtles do not allow us to make a definitive statement about the global extinction risks facing these sea turtles or risks facing particular populations (nesting aggregations) of these turtles. With the limited data available on green sea turtles, we do not know whether green sea turtles exist at population sizes large enough to avoid demographic phenomena that are known to increase the extinction probability of species that exist as "small" populations (that is, "small" populations experience phenomena such as demographic stochasticity, inbreeding depression and Allee effects, among others, that cause their population size to become a threat in and of itself) or if green sea turtles are threatened more by exogenous threats such as anthropogenic activities (entanglement, habitat loss, overharvests, etc.) or natural phenomena (such as disease, predation, or changes in the distribution and abundance of their prey in response to changing climate). Nevertheless, with the exception of the Hawai'i an nesting aggregations, we assume that green sea turtles are endangered because of both anthropogenic and natural threats as well as changes in their population dynamics.

Diving Behavior

Based on the behavior of post-hatchlings and juvenile green turtles raised in captivity, it is presumed that those in pelagic habitats live and feed at or near the ocean surface, and that their dives do not normally exceed several meters in depth (NMFS and USFWS 1998a). The maximum recorded dive depth for an adult green turtle was 110 meters (Berkson 1967 *in* Lutcavage and Lutz 1997), while subadults routinely dive 20 meters for 9-23 minutes, with a maximum recorded dive of 66 minutes (Brill *et al.* 1995 *in* Lutcavage and Lutz 1997).

Hearing

The information on green turtle hearing is very limited. Ridgway *et al.* (1969) studied the auditory evoked potentials of three green sea turtles (in air and through mechanical stimulation of the ear) and concluded that their maximum sensitivity occurred from 300 to 400 Hz with rapid declines for tones at lower and higher frequencies. They reported an upper limit for cochlear potentials without injury of 2000 Hz and a practical limit of about 1000 Hz. This is similar to estimates for loggerhead sea turtles, which had most sensitive hearing between 250 and 1000 Hz, with rapid decline above 1000 Hz (Bartol *et al.* 1999).

In a study of the auditory brainstem responses of subadult green sea turtles, Bartol and Ketten (2006) reported responses to frequencies between 100 and 500 Hz; with highest sensitivity between 200 and 400 Hz. They reported that two juvenile green turtles had hearing sensitivities that were slightly broader in range: they responded to sounds at frequencies from 100 to 800 Hz, with highest hearing sensitivities from 600 to 700 Hz.

These hearing sensitivities are similar to the hearing sensitivities reported for two terrestrial species: pond turtles (*Pseudemys scripta*) and wood turtles (*Chrysemys inscuplta*). Pond turtles are reported to have best hearing responsiveness 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 have sensitivities up to about 500 Hz, followed by a rapid decline above 1000 Hz and almost no responses beyond 3000 or 4000 Hz (Peterson 1966).

3.11. Hawksbill Sea Turtle

Distribution

Hawksbill sea turtles occur in tropical and subtropical seas of the Atlantic, Pacific and Indian Oceans. The species is widely distributed in the Caribbean Sea and western Atlantic Ocean, with individuals from several life history stages occurring regularly along southern Florida and the northern Gulf of Mexico (especially Texas); in the Greater and Lesser Antilles; and along the Central American mainland south to Brazil. Within the United States, hawksbills are most common in Puerto Rico and its associated islands, and in the U.S. Virgin Islands.

In the continental U.S., hawksbill sea turtles have been reported in every state on the coast of the Gulf of Mexico and along the coast of the Atlantic Ocean from Florida to Massachusetts, except for Connecticut; however, sightings of hawksbill sea turtles north of Florida are rare. The only states where hawksbill sea turtles occur with any regularity are Florida (particularly in the Florida Keys and the reefs off Palm Beach County on Florida’s Atlantic coast, where the warm waters of the Gulf Stream pass close to shore) and Texas. In both of these states, most sightings are of post-hatchlings and juveniles that are believed to have originated from nesting beaches in Mexico.

Hawksbill sea turtles have stranded along almost the entire Atlantic coast of the United States, although most stranding records occur south of Cape Canaveral, Florida, particularly in Palm Beach, Broward and Miami-Dade counties (Florida Sea Turtle Stranding and Salvage database). Hawksbill sea turtles are very rare north of Florida, although they have been recorded as far north as Massachusetts. During their pelagic-stage, hawksbills disperse from the Gulf of Mexico and southern Florida in the Gulfstream Current, which would carry them offshore of Georgia and the Carolinas. As evidence of this, a pelagic-stage hawksbill was captured 37 nautical miles east of Sapelo Island, Georgia in May 1994 (Parker 1995). There are also records of hawksbill sea turtles stranding on the coast of Georgia (Ruckdeschel *et al.*

2000), being captured in pound nets off Savannah, and being captured in summer flounder trawls (Epperly *et al.* 1995), gillnets (Epperly *et al.* 1995), and power plants off Georgia and the Carolinas.

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.

Hawksbill sea turtles occupy different habitats depending on their life history stage. After entering the sea, hawksbill sea turtles occupy pelagic waters and occupy weedlines that accumulate at convergence points. When they grow to about 20-25 cm carapace length, hawksbill sea turtles reenter coastal waters where they inhabit and forage in coral reefs as juveniles, subadults and adults. Hawksbill sea turtles also occur around rocky outcrops and high energy shoals, where sponges grow and provide forage, and they are known to inhabit mangrove-fringed bays and estuaries, particularly along the eastern shore of continents where coral reefs are absent (Hildebrand 1987, Amos 1989).

Population Structure

Hawksbill sea turtles, like other sea turtles, are divided into regional groupings that represent major oceans or seas: the Atlantic Ocean, Pacific Ocean, Indian Ocean, Caribbean Sea and Mediterranean Sea. In these regions, the population structure of hawksbill turtles is usually based on the distribution of their nesting aggregations.

Threats to the Species

Natural Threats. The various habitat types hawksbill sea turtles occupy throughout their lives exposes these sea turtles to a wide variety of natural threats. The beaches on which hawksbill sea turtles nest and the nests themselves are threatened by hurricanes and tropical storms as well as the storm surges, sand accretion, and rainfall that are associated with hurricanes. Hatchlings are hunted by predators like herons, gulls, dogfish, and sharks. Adult hawksbill sea turtles are also killed by sharks and other large, marine predators.

Anthropogenic Threats. Three human activities are known to threaten hawkbill sea turtles: overharvests of individual animals, incidental capture in commercial fisheries, and human development of coastlines. Historically, the primary cause of the global decline of hawkbill sea turtle populations was overharvest by humans for subsistence and commercial purposes. In the Atlantic, hawksbill sea turtles are still captured and killed in turtle fisheries in Colombia, Grenada, the Lesser Antilles, Nicaragua, St. Vincent and the Grenadines (Bräutigam and Eckert 2006).

For centuries, hawksbill sea turtles have been captured for their shells, which have commercial value, rather than food (the meat of hawksbill sea turtles is considered to have a bad taste and can be toxic to humans; NMFS and USFWS 1998b). Until recently, tens of thousands of hawksbills were captured and killed each year to meet demand for jewelry, ornamentation, and whole stuffed turtles (Milliken and Tokunaga *1987 cited in* Eckert 1993). 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 (Greenpeace 1989 *in* Eckert 1993).

Although Japan banned the importation of turtle shell in 1994, domestic harvests of eggs and turtles continue in the United States, its territories, and dependencies, particularly in the Caribbean and Pacific Island territories. 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 the demand for the hawksbill's shell, there is a demand for other products including leather, oil, perfume, and cosmetics. 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.

The second most important threat to hawksbill sea turtles is the loss of nesting habitat caused by the expansion of resident human populations in coastal areas of the world and increased destruction or modification of coastal ecosystems to support tourism. Hawksbill sea turtles are also captured and killed in commercial fisheries. Along the Atlantic coast of the U.S., NMFS estimated that about 650 hawksbill sea turtles are captured in shrimp trawl fisheries each year in the Gulf of Mexico, with most of those sea turtles dying as a result of their capture (see Table 8). Each year, about 35 hawksbill sea turtles are captured in Atlantic pelagic longline fisheries. Although most of these turtles are released alive, these fisheries are expected to kill about 50 hawksbill sea turtles each year; the health effects of being captured on the sea turtles that survive remain unknown.

Like green sea turtles, hawksbill sea turtles are threatened by domestic or domesticated animals that prey on their nests; artificial lighting that disorients adult female and hatchling sea turtles, which can dramatically increase the mortality rates of hatchling sea turtles; beach replenishment; ingestion and entanglement in marine debris; and environmental contaminants.

Status

Hawksbill sea turtles were listed as endangered under the ESA in 1970. Under Appendix I of the Convention on International Trade in Endangered Species of Wild Fauna and Flora, hawksbill sea turtles are identified as "most endangered."

Hawksbill sea turtles are solitary nesters, which makes it difficult to estimate the size of their populations. There are no global estimates of the number of hawksbill sea turtles, but a minimum of 15,000 to 25,000 females are thought to nest annually in more than 60 geopolitical entities (Groombridge and Luxmoore 1989). Moderate populations appear to persist around the Solomon Islands, northern Australia, Palau, Persian Gule islands, Oman, and parts of the Seychelles (Groombridge 1982). In a more recent review, Groombridge and Luxmoore (1989) list Papua New Guinea, Queensland, and Western Australia as likely to host 500-1,000 nesting females per year, while Indonesia and the Seychelles may support >1,000 nesting females. The largest known nesting colony in the world is located on Milman Island, Queensland, Australia where Loop (1995) tagged 365 hawksbills nesting within an 11 week period. With the exception of Mexico, and possibly Cuba, nearly all Wider Caribbean countries are estimated to receive <100 nesting females per year (Meylan 1989).

Of the 65 geopolitical units on which hawksbill sea turtles nest and where hawksbill nesting densities can be estimated, 38 geopolitical units have hawksbill populations that are suspected or known to be declining. Another 18 geopolitical units have experienced well-substantiated declines (NMFS and USFWS 1995). The largest remaining nesting concentrations occur on remote oceanic islands off Australia (Torres Strait) and the Indian Ocean (Seychelles).

Hawksbill sea turtles, like green sea turtles, are thought to be declining globally as a direct consequence of a historical combination of overexploitation and habitat loss. However, like several of the species we have already discussed, the information available on the status and trend of hawksbill sea turtles does not allow us to make definitive statements about the global extinction risks facing these sea turtles or the risks facing particular populations (nesting aggregations) of these turtles. However, the limited data available suggests that several hawksbill sea turtles populations exist at sizes small enough to be classified as "small" populations (that is, populations that exhibit population dynamics that increase the extinction probabilities of the species or several of its populations) while others are large enough to avoid these problems. Exogenous threats such as overharvests and entanglement in fishing gear only increase their probabilities of becoming extinct in the foreseeable future.

Diving Behavior

The duration of foraging dives in hawksbill sea turtles commonly depends on the size of the turtle: larger turtles diving deeper and longer. At a study site in the northern Caribbean, foraging dives were made only during the day and dive durations ranged from 19-26 minutes in duration at depths of 8-10 m. At night, resting dives ranged from 35-47 minutes in duration (Van Dam and Diez, 1997).

Hearing

There is no information on hawksbill sea turtle vocalizations or hearing. However, we assume that their hearing sensitivities will be similar to those of green and loggerhead sea turtles with their best hearing sensitivity in the low frequency range: from 200 to 400 Hz with rapid declines for tones at lower and higher frequencies. Their hearing will probably have a practical upper limit of about 1000 Hz (Bartol *et al*. 1999, Ridgway *et al*. 1969).

These hearing sensitivities are similar to the hearing sensitivities reported for two terrestrial species: pond turtles (*Pseudemys scripta*) and wood turtles (*Chrysemys inscuplta*). Pond turtles are reported to have best hearing responsiveness 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 have sensitivities up to about 500 Hz, followed by a rapid decline above 1000 Hz and almost no responses beyond 3000 or 4000 Hz (Peterson 1966).

3.12. Kemp's Ridley Sea Turtle

Distribution

Adult Kemp's ridley turtles are restricted to the Gulf of Mexico in shallow near shore waters, although adult-sized individuals sometimes are found on the eastern seaboard of the United States. Females rarely leave the Gulf of Mexico and adult males do not migrate. Juveniles feed along the east coast of the United States up to the waters off Cape Cod, Massachusetts (Spotila 2004). A small number of individuals reach European waters (Brongersma 1972, Spotila 2004) and the Mediterranean (Pritchard and Marquez-M. 1973).

Juvenile Kemp's ridley sea turtles are the second most abundant sea turtle in the mid-Atlantic region from New England, New York, and the Chesapeake Bay, south to coastal areas off North Carolina. Juvenile Kemp's ridley sea turtles migrate into the region during May and June and forage for crabs in submerged aquatic vegetation (Keinath *et al*. 1987, Musick and Limpus 1997). In the fall, they migrate south along the coast, forming one of the densest concentrations of Kemp's ridley sea turtles outside of the Gulf of Mexico (Musick and Limpus 1997).

Population Structure

Unlike the other sea turtles discussed here, adult Kemp's ridley sea turtles are generally restricted to the Gulf of Mexico. Almost 95 percent of all Kemp's ridley sea turtle nesting occurs on the beaches of Rancho Nuevo, Tepehuajes, and Barra del Tordo in the State of Tamaulipas, Mexico. Nesting also occurs in Veracruz, Mexico, and Texas, U.S., but on a much smaller scale. Occasional nesting has been documented in North Carolina, South Carolina, and the Gulf and Atlantic coasts of Florida. As a general matter, Kemp's ridley sea turtles are treated as a single population.

Threats to the Species

Natural Threats. Kemp's ridley sea turtles are exposed to a wide variety of threats during every stage of their lives. Eggs and hatchlings on nesting beaches are preyed upon by coyotes, raccoons, coatis, skunks, ghost crabs, ants, and to lesser degrees hawks, vultures, grackles, and caracaras (Dodd 1988, Hirth 1971, Witzell 1983). Those hatchlings that reach the ocean are preyed upon by gulls, terns, sharks, and predatory fish (Dodd 1988). Sharks and other large marine predators prey on large juvenile Kemp's ridley sea turtles.

Because of their restricted geographic distribution, the concentration of most nesting activity at one beach, and the frequency of hurricanes in the Gulf of Mexico, hurricanes represent a substantial threat to Kemp's ridley sea turtles. For example, in 1988 Hurricane Gilbert struck the primary nesting beach, destroyed many of the nests, and altered the structure of the nesting beach.

Anthropogenic Threats. Several human activities contributed to the endangerment of Kemp's ridley sea turtles: harvests of eggs on nesting beaches, incidental capture in fisheries, loss of foraging habitat, and marine pollution. In 1947, 40,000 female Kemp's ridley sea turtles were observed nesting on the beaches at Rancho Nuevo on a single day (Carr 1963, Hildebrand 1963). From the 1940s through the early 1960s, nests on the beaches of Rancho Nuevo, Mexico, were heavily poached but beach protection in 1966 helped to curtail this activity (USFWS and NMFS 1992). By the mid-1960s the number of females nesting on the same beaches had declined to about 1,300 on a single day (Chavez *et al*. 1967).

Kemp's ridley sea turtles have been captured and killed by fishing gear in several Federal and state fisheries throughout their range. They have been captured in gear used in lobster fisheries and monkfish fisheries off the northeastern United States, pound net fisheries off eastern Long Island, the mid-Atlantic, and Chesapeake Bay; fisheries for squid, mackerel, butterfish, bluefish, summer flounder, Atlantic herring, weakfish, and the sargassum fishery. The most significant fishery-related threat to Kemp's ridley sea turtles has been the number of sea turtles that have been captured and killed in the shrimp trawl fisheries in the Gulf of Mexico.

Kemp's ridley sea turtles have also been captured and killed as a result of entrainment in power plants along the coast of the United States and coastal dredging.

Recovery actions. Kemp's ridley sea turtles have benefited from a concentrated recovery effort that began in the mid-1960s when the government of Mexico established a program to protect eggs on the beach of Rancho Nuevo. In 1977, a Mexican presidential decree included the Rancho Nuevo Nesting Beach Natural Reserve as part of a system of reserves for sea turtles. In 1978, an experiment to "head start" Kemp's ridley sea turtles was implemented as part of a larger effort to recover the species. From 1978 to 1991, under a cooperative beach patrol effort involving personnel from both countries, the number of released hatchlings was increased to a yearly average of 54,676 individuals. In 1990 a complete ban on taking any species of sea turtle was established by the Government of Mexico.

Status

Kemp's ridley sea turtles were listed as endangered on December 2, 1970 (35 FR 18320). There is no designated critical habitat for the Kemp's ridley sea turtle.

In 1947, 40,000 female Kemp's ridley sea turtles were observed nesting on the beaches at Rancho Nuevo on a single day (Carr 1963, Hildebrand 1963). By the early 1970s, the estimate of mature female Kemp's ridleys had been reduced to 2,500-5,000 individuals. Between the years of 1978 and 1991 only 200 Kemp's ridleys nested annually. Today the Kemp's ridley population appears to be in the early stages of recovery. Nesting has increased steadily over the past decade and the total annual number of nests recorded at Rancho Nuevo and adjacent camps has exceeded 10,000 in recent years. Over 20,000 nests were recorded in 2009 at Rancho Nuevo and adjacent camps. From 2002-2009, a total of 771 Kemp's ridley nests have been documented on the Texas coast. This is more than nine times greater than the 81 nests recorded over the previous 54 years from 1948-2001, indicating an increasing nesting population in Texas. From 2005 through 2009, the number of nests from all monitored beaches indicate approximately 5,500 females are nesting each season in the Gulf of Mexico (NMFS and USFWS 2010b).

The Turtle Expert Working Group (2000) estimated that the population size of Kemp's ridley sea turtles grew at an average rate of l1.3 percent per year (95% C.I. slope = 0.096-0.130) between 1985 and 1998. Over the same time interval, hatchling production increased at a slightly slower rate (9.5% per year). Population models predict the population will grow 12-16% per year, for the near future, assuming current survival rates within each life stage remain constant (Heppell *et al*. 2005 *in* NMFS 2010b).

Hearing

There is no information on the vocalizations or hearing of Kemp's ridley sea turtles. However, we assume that their hearing sensitivities would be similar to those of green and loggerhead sea turtles: their best hearing sensitivity would be in the low frequency range: from 200 to 400 Hz with rapid declines for tones at lower and higher frequencies. Their hearing would probably have a practical upper limit of about 1000 Hz (Bartol *et al*. 1999, Ridgway *et al*. 1969).

These hearing sensitivities are similar to the hearing sensitivities reported for two terrestrial species: pond turtles (*Pseudemys scripta*) and wood turtles (*Chrysemys inscuplta*). Pond turtles are reported to have best hearing responsiveness 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 have sensitivities up to about 500 Hz, followed by a rapid decline above 1000 Hz and almost no responses beyond 3000 or 4000 Hz (Peterson 1966).

3.13. Leatherback Sea Turtle

Distribution

Leatherback turtles are widely distributed throughout the oceans of the world. The species is found in four main regions of the world: the Pacific, Atlantic, and Indian Oceans, and the Caribbean Sea. Leatherbacks also occur in the Mediterranean Sea, although they are not known to nest there. The four main regional areas may further be divided into nesting aggregations. Leatherback turtles are found on the western and eastern coasts of the Pacific Ocean, with nesting aggregations in Mexico and Costa Rica (eastern Pacific) and Malaysia, Indonesia, Australia, the Solomon Islands, Papua New Guinea, Thailand, and Fiji (western Pacific). In the Atlantic Ocean, leatherback nesting aggregations have been documented in Gabon, Sao Tome and Principe, French Guiana, Suriname, and Florida. In the Caribbean, leatherbacks nest in the U.S. Virgin Islands and Puerto Rico. In the Indian Ocean, leatherback nesting aggregations are reported in India and Sri Lanka.

Leatherback sea turtles are highly migratory, exploiting convergence zones and upwelling areas in the open ocean, along continental margins, and in archipelagic waters (Morreale *et al.* 1994, Eckert 1998, Eckert 1999). In a single year, a leatherback may swim more than 10,000 kilometers (Eckert 1998). In the North Atlantic Ocean, leatherback turtles regularly occur in deep waters (>328 ft), and an aerial survey study in the north Atlantic sighted leatherback turtles in water depths ranging from 3 to 13,618 ft, with a median sighting depth of 131.6 ft (CeTAP 1982). This same study found leatherbacks in waters ranging from 7 to 27.2°C. In the Pacific Ocean, leatherback turtles have the most extensive range of any living reptile and have been reported in all pelagic waters of the Pacific between 71°N and 47 °S latitude and in all other major pelagic ocean habitats (NMFS and USFWS 1998c). Leatherback turtles lead a completely pelagic existence, foraging widely in temperate waters except during the nesting season, when gravid females return to tropical beaches to lay eggs. Males are rarely observed near nesting areas, and it has been hypothesized that leatherback sea turtles probably mate outside of tropical waters, before females swim to their nesting beaches (Eckert and Eckert 1988).

Leatherback turtles are uncommon in the insular Pacific Ocean, but individual leatherback turtles are sometimes encountered in deep water and prominent archipelagoes. To a large extent, the oceanic distribution of leatherback turtles may reflect the distribution and abundance of their macroplanktonic prey, which includes medusae, siphonophores, and salpae in temperate and boreal latitudes (NMFS and USFWS 1995). There is little information available on their diet in subarctic waters.

Population Structure

Leatherback turtles are widely distributed throughout the oceans of the world. The species is divided into four main populations in the Pacific, Atlantic, and Indian Oceans, and the Caribbean Sea. Leatherbacks also occur in the Mediterranean Sea, although they are not known to nest there. The four main populations are further divided into nesting aggregations. Leatherback turtles are found on the western and eastern coasts of the Pacific Ocean, with nesting aggregations in Mexico and Costa Rica (eastern Pacific) and Malaysia, Indonesia, Australia, the Solomon Islands, Papua New Guinea, Thailand, and Fiji (western Pacific). In the Atlantic Ocean, leatherback nesting aggregations have been documented in Gabon, Sao Tome and Principe, French Guiana, Suriname, and Florida. In the Caribbean, leatherbacks nest in the U.S. Virgin Islands and Puerto Rico. In the Indian Ocean, leatherback nesting aggregations are reported in India, Sri Lanka, and the Andaman and Nicobar Islands.

Threats to the Species

Natural Threats. The various habitat types leatherback sea turtles occupy throughout their lives exposes these sea turtles to a wide variety of natural threats. The beaches on which leatherback sea turtles nest and the nests themselves are threatened by hurricanes and tropical storms as well as the storm surges, sand accretion, and rainfall that are associated with hurricanes. Hatchlings are hunted by predators like herons, gulls, dogfish, and sharks. Larger leatherback sea turtles, including adults, are also killed by sharks and other large, marine predators.

Anthropogenic Threats. Leatherback sea turtles are endangered by several human activities, including fisheries interactions, entanglement in fishing gear (e.g., gillnets, longlines, lobster pots, weirs), direct harvest, egg collection, the destruction and degradation of nesting and coastal habitat, boat collisions, and ingestion of marine debris (NMFS and USFWS 2007a).

The foremost threat is the number of leatherback turtles killed or injured in fisheries (see Table 8). 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). Spotila (2000) asserts that most of the mortality associated with the Playa Grande nesting site was fishery related.

Leatherback sea turtles are exposed to commercial fisheries in many areas of the Atlantic Ocean. For example, leatherback entanglements in fishing gear are common in Canadian waters where Goff and Lien (1988) reported that 14 of 20 leatherbacks encountered off the coast of Newfoundland and Labrador were entangled in fishing gear including salmon net, herring net, gillnet, trawl line and crab pot line. Leatherbacks are reported taken by the many other nations that participate in Atlantic pelagic longline fisheries (see NMFS 2001, for a complete description of take records), including Taiwan, Brazil, Trinidad, Morocco, Cyprus, Venezuela, Korea, Mexico, Cuba, U.K., Bermuda, People's Republic of China, Grenada, Canada, Belize, France, and Ireland.

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 Hawai'i 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 Hawai'i are estimated to have captured about 19 leatherback sea turtles, killing about 5 of these sea turtles. A recent biological opinion on these fisheries expected this rate of interaction and deaths to continue into the foreseeable future (NMFS 2008). Leatherback sea turtles have also been and are expected to continue to be captured and killed in the deep-set based longline fisheries based out of Hawai'i and American Samoa.

Shrimp trawls in the Gulf of Mexico capture the largest number of leatherback sea turtles: each year, they have been estimated to capture about 3,000 leatherback sea turtles with 80 of those sea turtles dying as a result. Along the Atlantic coast of the U.S., NMFS estimated that about 800 leatherback sea turtles are captured in pelagic longline fisheries, bottom longline and drift gillnet fisheries for sharks as well as lobster, deep-sea red crab, Jonah crab, dolphin fish and wahoo, and Pamlico Sound gillnet fisheries. Although most of these turtles are released alive, these fisheries combined kill about 300 leatherback sea turtles each year; the health effects of being captured on the sea turtles that survive remain unknown.

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 *et al.* 1998). Observers on shrimp trawlers operating in the northeastern region of Venezuela documented the capture of six leatherbacks from 13,600 trawls (Marcano and Alio, 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 2001). There are known to be many sizeable populations of leatherbacks nesting in West Africa, possibly as many as 20,000 females nesting annually (Fretey 2001). In Ghana, nearly two thirds of the leatherback turtles that come up to nest on the beach are killed by local fishermen.

On some beaches, nearly 100% of the eggs laid have been harvested. Eckert (1996) and Spotila *et al.* (1996) note that adult mortality has also increased significantly, particularly as a result of driftnet and longline fisheries. Like green and hawksbill sea turtles, leatherback sea turtles are threatened by domestic or domesticated animals that prey on their nests; artificial lighting that disorients adult female and hatchling sea turtles, which can dramatically increase the mortality rates of hatchling sea turtles; beach replenishment; ingestion and entanglement in marine debris; and environmental contaminants.

Status

The leatherback turtles are listed as endangered under the ESA throughout the species' global range. Increases in the number of nesting females have been noted at some sites in the Atlantic Ocean, but these are far outweighed by local extinctions, especially of island populations, and the demise of populations throughout the Pacific, such as in Malaysia and Mexico. Spotila *et al.* (1996) estimated the global population of female leatherback turtles to be only 34,500 (confidence limits: 26,200 to 42,900) nesting females; however, the eastern Pacific population has continued to decline since that estimate, leading some researchers to conclude that the leatherback is now on the verge of extinction in the Pacific Ocean (e.g. Spotila *et al.* 1996, Spotila, *et al.* 2000).

Globally, leatherback turtle populations have been decimated worldwide. In 1980, the global leatherback population was estimated at approximately 115,000 adult females (Pritchard 1982). By 1995, this global population (of adult females) is estimated to have declined to 34,500 (Spotila *et al.* 1996). Populations have declined in Mexico, Costa Rica, Malaysia, India, Sri Lanka, Thailand, Trinidad, Tobago, and Papua New Guinea. Throughout the Pacific, leatherbacks are seriously declining at all major nesting beaches.

In the Atlantic and Caribbean, the largest nesting assemblages of leatherbacks are found in the U.S. Virgin Islands, Puerto Rico, and Florida. Since the early 1980s, nesting data has been collected at these locations. Populations in the eastern Atlantic (*i.e.* off Africa) and Caribbean appear to be stable; however, information regarding the status of the entire leatherback population in the Atlantic is lacking and it is certain that some nesting populations (*e.g.*, St. John and St. Thomas, U.S. Virgin Islands) have been extirpated (NMFS and USFWS 1995). Data collected in southeast Florida clearly indicate increasing numbers of nests for the past twenty years (9.1-11.5% increase), although it is critical to note that there was also an increase in the survey area in Florida over time (NMFS 2001). However, the largest leatherback rookery in the western North Atlantic remains along the northern coast of South America in French Guiana and Suriname. Recent information suggests that Western Atlantic populations declined from 18,800 nesting females in 1996 (Spotila *et al.* 1996) to 15,000 nesting females by 2000 (Spotila, personal communication *cited in* NMFS 2001). The nesting population of leatherback turtles in the Suriname-French Guiana trans-boundary region has been declining since 1992 (Chevalier and Girondot, 1998). Poaching and fishing gear interactions are believed to be the major contributors to the decline of leatherbacks in the area.

Leatherback sea turtles appear to be in a critical state of decline in the North Pacific Ocean. The leatherback population that nests along the east Pacific Ocean was estimated to be over 91,000 adults in 1980 (Spotila 1996), but is now estimated to number less than 3,000 total adult and subadult animals (Spotila 2000). Leatherback turtles have experienced major declines at all major Pacific basin rookeries.

At Mexiquillo, Michoacan, Mexico, Sarti *et al.* (1996) reported an average annual decline in nesting of about 23% between 1984 and 1996. The total number of females nesting on the Pacific coast of Mexico during the 1995-1996 season was estimated at fewer than 1,000. Less than 700 females are estimated for Central America (Spotila 2000). In the western Pacific, the decline is equally severe. Current nestings at Terengganu, Malaysia represent 1% of the levels recorded in the 1950s (Chan and Liew 1996).

While Spotila *et al.* (1996) indicated that turtles may have been shifting their nesting from French Guiana to Suriname due to beach erosion, analyses show that the overall area trend in number of nests has been negative since 1987 at a rate of 15.0 -17.3 % per year (NMFS 2001). If turtles are not nesting elsewhere, it appears that the Western Atlantic portion of the population is being subjected to mortality beyond sustainable levels, resulting in a continued decline in numbers of nesting females.

Based on published estimates of nesting female abundance, leatherback populations are declining at all major Pacific basin nesting beaches, particularly in the last two decades (Spotila *et al.* 1996, NMFS and USFWS 1998c, Spotila *et al.* 2000). Declines in nesting populations have been documented through systematic beach counts or surveys in Malaysia (Rantau Abang, Terengganu), Mexico and Costa Rica. In other leatherback nesting areas, such as Papua New Guinea, Indonesia, and the Solomon Islands, there have been no systematic consistent nesting surveys, so it is difficult to assess the status and trends of leatherback turtles at these beaches. In all areas where leatherback nesting has been documented, however, current nesting populations are reported by scientists, government officials, and local observers to be well below abundance levels of several decades ago. The collapse of these nesting populations was most likely precipitated by a tremendous overharvest of eggs coupled with incidental mortality from fishing (Sarti *et al.* 1996, Eckert, 1997).

Based on recent modeling efforts, some authors concluded that leatherback turtle populations cannot withstand more than a 1% human-related mortality level which translates to 150 nesting females (Spotila *et al.* 1996). As noted previously, there are many human-related sources of mortality to leatherbacks; every year, 1,800 leatherback turtles are expected to be captured or killed as a result of federally-managed activities in the U.S. (this total includes both lethal and non-lethal take). An unknown number of leatherbacks are captured or killed in fisheries managed by states. Spotila *et al.* (1996) recommended not only reducing fishery-related mortalities, but also advocated protecting eggs and hatchlings. Zug and Parham (1996) point out that a combination of the loss of long-lived adults in fishery-related mortalities and a lack of recruitment stemming from elimination of annual influxes of hatchlings because of intense egg harvesting has caused the sharp decline in leatherback populations.

For several years, NMFS' biological opinions have established that leatherback populations currently face high probabilities of extinction as a result of both environmental and demographic stochasticity. Demographic stochasticity, which is chance variation in the birth or death of an individual of the population, is facilitated by the increases in mortality rates of leatherback populations resulting from the premature deaths of individual sea turtles associated with human activities (either removal of eggs or adult females that are killed on nesting beaches or that die as a result of being captured in fisheries) or incidental capture and mortality of individuals in various fisheries.

In the Pacific Ocean, leatherback sea turtles are critically endangered as a direct consequence of a historical combination of overexploitation and habitat loss. The information available suggests that leatherback sea turtles have high probabilities of becoming extinct in the Pacific Ocean unless they are protected from the combined threats of entanglements in fishing gear, overharvests, and loss of their nesting habitat. The limited data available suggests that leatherback sea turtles exist at population sizes small enough to be classified as "small" populations (that is, populations that exhibit population dynamics that increase the extinction probabilities of the species or several of its populations) as evidenced by biases in the male to female ratios in the Pacific. The status of leatherback sea turtles in the Atlantic Ocean remains uncertain.

Diving Behavior

The maximum dive depths for post-nesting female leatherback turtles in the Caribbean have been recorded at 475 meters and over 1,000 meters, with routine dives recorded at between 50 and 84 meters. The maximum dive length recorded for such female leatherback turtles was 37.4 minutes, while routine dives ranged from 4 -14.5 minutes (*in* Lutcavage and Lutz 1997). Leatherback turtles also appear to spend almost the entire portion of each dive traveling to and from maximum depth, suggesting that maximum exploitation of the water column is of paramount importance to the leatherback (Eckert *et al.* 1989).

A total of six adult female leatherback turtles from Playa Grande, Costa Rica were monitored at sea during their internesting intervals and during the 1995 through 1998 nesting seasons. The turtles dived continuously for the majority of their time at sea, spending 57 - 68% of their time submerged. Mean dive depth was 19±1 meters and the mean dive duration was 7.4± 0.6 minutes (Southwood *et al.* 1999). Similarly, Eckert (1999) placed transmitters on nine leatherback females nesting at Mexiquillo Beach and recorded dive behavior during the nesting season. The majority of the dives were less than 150 meters depth, although maximum depths ranged from 132 meters to over 750 meters. Although the dive durations varied between individuals, the majority of them made a large proportion of very short dives (less than two minutes), although Eckert (1999) speculates that these short duration dives most likely represent just surfacing activity after each dive. Excluding these short dives, five of the turtles had dive durations greater than 24 minutes, while three others had dive durations between 12 - 16 minutes.

Migrating leatherback turtles also spend a majority of time at sea submerged, and they display a pattern of continual diving (Standora *et al.* 1984, *in* Southwood *et al.* 1999). Based on depth profiles of four leatherbacks tagged and tracked from Monterey Bay, California in 2000 and 2001, using satellite-linked dive recorders, most of the dives were to depths of less than 100 meters and most of the time was spent shallower than 80 meters. Based on preliminary analyses of the data, 75-90% of the time the leatherback turtles were at depths less than 80 meters.

Hearing

There is no information on the vocalizations or hearing of leatherback sea turtles. However, we assume that their hearing sensitivities will be similar to those of green and loggerhead sea turtles: their best hearing sensitivity will be in the low frequency range: from 200 to 400 Hz with rapid declines for tones at lower and higher frequencies. Their hearing will probably have a practical upper limit of about 1000 Hz (Bartol *et al.* 1999, Ridgway *et al.* 1969).

These hearing sensitivities are similar to the hearing sensitivities reported for two terrestrial species: pond turtles (*Pseudemys scripta*) and wood turtles (*Chrysemys inscuplta*). Pond turtles are reported to have best hearing responsiveness 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 have sensitivities up to about 500 Hz, followed by a rapid decline above 1000 Hz and almost no responses beyond 3000 or 4000 Hz (Peterson 1966).

3.14. Loggerhead Sea Turtle

Distribution

Loggerheads are circumglobal, inhabiting continental shelves, bays, estuaries, and lagoons in temperate, subtropical, and tropical waters. Major nesting grounds are generally located in temperate and subtropical regions, with scattered nesting in the tropics in the Atlantic, Pacific and Indian Oceans and the Mediterranean Sea (NMFS and USFWS 1998). The majority of loggerhead nesting is at the western rims of the Atlantic and Indian Oceans. Nesting aggregations occur in the eastern Atlantic at Cape Verde, Greece, Libya, Turkey and along the West African Coast. The western Atlantic and Caribbean hosts nesting aggregations along the U.S. east coast from Virginia through the Florida peninsula, the Dry Tortugas and Northern Gulf of Mexico, the Bahamas, the Yucatan Peninsula, Central America and the Caribbean and into South America. Within the Indian Ocean, nesting aggregations occur at Oman, Yemen, Sri Lanka and Madagascar and South Africa. Pacific Ocean nesting sites include western and eastern Australia and Japan.

Adult loggerheads are known to make considerable migrations from nesting beaches to foraging grounds (TEWG 2009); and evidence indicates turtles entering the benthic environment undertake routine migrations along the coast that are limited by seasonal water temperatures. Small juveniles are found in pelagic waters (e.g., of the North Atlantic and the Mediterranean Sea); and the transition from oceanic to neritic juvenile stages can involve trans-oceanic migrations (Bowen *et al.* 2004). Loggerhead nesting is confined to lower latitudes, concentrated in temperate zones and subtropics; the species generally does not nest in tropical areas (NRC 1990; NMFS and USFWS 1991; Witherington *et al.* 2006). Loggerhead turtles travel to northern waters during spring and summer as water temperatures warm, and southward and offshore toward warmer waters in fall and winter; loggerheads are noted to occur year round in offshore waters of sufficient temperature.

Population Structure

Loggerhead sea turtles, like other sea turtles, are divided into regional groupings that represent major oceans or seas: the Atlantic Ocean, Pacific Ocean, Indian Ocean, Caribbean Sea and Mediterranean Sea. In these regions, the population structure of loggerhead turtles is usually based on the distribution of their nesting aggregations. Loggerhead sea turtles are currently listed globally as a threatened species.

Threats to the Species

Natural Threats. The various habitat types loggerhead sea turtles occupy throughout their lives exposes these sea turtles to a wide variety of natural and anthropogenic threats. The beaches on which loggerhead sea turtles nest and the nests themselves are threatened by hurricanes and tropical storms as well as the storm surges, sand accretion, and rainfall that are associated with hurricanes. For example, in 1992, all of the eggs over a 90-mile length of coastal Florida were destroyed by storm surges on beaches that were closest to the eye of Hurricane Andrew (Milton *et al.* 1994). Hatchlings are hunted by predators like herons, gulls, dogfish, and sharks. Adult loggerhead sea turtles are also killed by sharks and other large, marine predators. Loggerhead sea turtles are also killed by cold stunning, exposure to biotoxins, sharks and other large, marine predators.

Anthropogenic Threats. A wide variety of human activities adversely affect hatchlings and adult female turtles when they are on land, including beach erosion, beach armoring and nourishment; artificial lighting; beach cleaning; human presence on nesting beaches; beach driving; coastal construction and fishing piers that alter patterns of erosion and accretion on nesting beaches; exotic dune and beach vegetation; and poaching. As the size of the human population in coastal areas increases, that population brings with it secondary threats such as exotic fire ants, feral hogs, dogs, and the growth of populations of native species that tolerate human presence (*e.g.*, raccoons, armadillos, and opossums) and which feed on turtle eggs.

When they are in coastal or marine waters, loggerhead turtles are affected by a completely different set of human activities that include discharges of toxic chemicals and other pollutants into the marine ecosystem; underwater explosions; hopper dredging, offshore artificial lighting; entrainment or impingement in power plants; entanglement in marine debris; ingestion of marine debris; boat collisions; poaching, and interactions with commercial fisheries. Interactions with fisheries represent a primary threat because of the number of individuals that are captured and killed in fishing gear each year (See Table 8).

Table 8: Number of different species of sea turtles that NMFS expected to be "taken" (generally captured and harassed, harmed, wounded, or killed) and the number that are expected to be killed in commercial fisheries managed by NMFS off the Atlantic Coast, based on numbers contained in incidental take statements in biological opinions on those fisheries. Numbers are generally annual estimates (after Griffin *et al*. 2006 and updated biological opinions since 2006)

Fishery	NMFS Region	Loggerhead		Leatherback		Green		Hawksbill		Total	
		Total Take	# Killed	Total Take	# Killed	Total Take	# Killed	Total Take	# Killed	Total Take	# Killed
Bluefish	NER	6	3	0	0	0	0	0	0	6	3
Deep-sea red crab	NER	1	1	1	1	0	0	0	0	2	2
Herring	NER	6	3	1	1	1	1	0	0	8	5
Jonah crab	NER	0	0	2	2	0	0	0	0	2	2
Lobster	NER	2	2	5	5	0	0	0	0	7	7
Mackerel, squid, butterfish	NER	6	3	1	1	2	2	0	0	9	6
Monkfish	NER	4	1	2	1	2	1	0	0	8	3
Multispecies	NER	1	1	1	1	1	1	0	0	3	3
Pound net (Virginia)	NER	507	2	2	2	3	2	0	0	512	6
Sea scallop	NER	754	484	2	2	2	2	0	0	760	490
Skate	NER	1	1	1	1	1	1	0	0	3	3
Spiny dogfish	NER	3	2	1	1	1	1	0	0	5	4
Stone Crab	SER	16	4	1	0	4	3	1	0		
Summer flounder, scup, sea bass	NER	19	5	0	0	2	2	0	0	21	7
Tilefish	NER	6	3	1	1	0	0	0	0	7	4
Dolphin fish and wahoo	SER	12	2	12	1	2	1	2	1	28	5
Atlantic pelagic	SER	623	146	660	183	35	8	35	8	1353	345
Sargassum	SER	3	3	0	0	0	0	0	0	3	3
Shark bottom longline and drift gillnet	SER	679	346	47	74	2	1	2	1	320	171

Table 8: Number of different species of sea turtles that NMFS expected to be "taken" (generally captured and harassed, harmed, wounded, or killed) and the number that are expected to be killed in commercial fisheries managed by NMFS off the Atlantic Coast, based on numbers contained in incidental take statements in biological opinions on those fisheries. Numbers are generally annual estimates (after Griffin *et al*. 2006 and updated biological opinions since 2006)

Fishery	NMFS Region	Loggerhead		Leatherback		Green		Hawksbill		Total	
		Total Take	# Killed	Total Take	# Killed	Total Take	# Killed	Total Take	# Killed	Total Take	# Killed
Pamlico Sound gillnet	SER	41	3	2	2	168	46	2	2	213	53
Shrimp trawling	SER	163160	3948	3090	80	18757	514	0	640	185007	5182
Totals		**165850**	**4963**	**3822**	**359**	**18883**	**586**	**87***	**652**	**188277**	**6304**

***** The biological opinion on shrimp trawl fisheries did not estimate the number of hawksbill sea turtles that might be captured in the fisheries, although it estimated the number that might be killed. Obviously, the fisheries would have to capture at least 640 hawksbill sea turtles to kill that many sea turtles.

Loggerhead sea turtles are also captured and killed in commercial fisheries. 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 Hawai'i 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 Hawai'i are estimated to have captured about 45 loggerhead sea turtles, killing about 10 of these sea turtles. A recent biological opinion on these fisheries expected this rate of interaction and deaths to continue into the foreseeable future (NMFS 2008). Loggerhead sea turtles have also been and are expected to continue to be captured and killed in the deep-set based longline fisheries based out of Hawai'i and American Samoa.

Shrimp trawl fisheries account for the highest number of loggerhead sea turtles that are captured and killed, but they are also captured and killed in trawls, traps and pots, longlines, and dredges. Along the Atlantic coast of the U.S., NMFS estimated that almost 163,000 loggerhead sea turtles are captured in shrimp trawl fisheries each year in the Gulf of Mexico, with 3,948 of those sea turtles dying as a result of their capture. Each year, several hundred loggerhead sea turtles are also captured in herring fisheries; mackerel, squid, and butterfish fisheries; monkfish fisheries; pound net fisheries, summer flounder and scup fisheries; Atlantic pelagic longline fisheries; and gillnet fisheries in Pamlico Sound. Although most of these turtles are released alive, these fisheries capture about 2,000 loggehead sea turtles each year, killing almost 700; the effects of capture-related stress on the current or expected future reproductive success of sea turtles remains unknown.

In the pelagic environment, loggerhead sea turtles are exposed to a series of longline fisheries that include the U.S. Atlantic tuna and swordfish longline fisheries, an Azorean longline fleet, a Spanish longline fleet, and various fleets in the Mediterranean Sea (Aguilar *et al.* 1995, Bolten *et al.* 1994, Crouse 1999). In the benthic environment in waters off the coastal U.S., loggerheads are exposed to a suite of fisheries in federal and state waters including trawl, purse seine, hook and line, gillnet, pound net, longline, dredge, and trap fisheries.

Like all of the other sea turtles we have discussed, loggerhead sea turtles are threatened by domestic or domesticated animals that prey on their nests; artificial lighting that disorients adult female and hatchling sea turtles, which can dramatically increase the mortality rates of hatchling sea turtles; beach replenishment; ingestion and entanglement in marine debris; and environmental contaminants.

Status

Loggerhead sea turtles are currently listed as threatened under the ESA throughout its global range. In 2010 NMFS and FWS published a proposed rule to list several distinct population segments (DPS) of loggerhead sea turtles (75 FR 12598, March 16, 2010). Two DPSs are proposed for the Pacific Ocean, three in the Indian Ocean, and four in the Atlantic Ocean/Mediterranean Sea (See Table 9).

Table 9: Proposed Loggerhead Sea Turtle Distinct Population Segments

Population Segment	Historic Range	Population Boundaries	Proposed Status
Mediterranean Sea	Mediterranean Sea Basin	Mediterranean Sea east of 5°36' W. Long.	Endangered
North Indian Ocean	North Indian Ocean Basin	North Indian Ocean north of the equator and south of 30° N. Lat.	Endangered
North Pacific Ocean	North Pacific Ocean Basin	North Pacific north of the equator and south of 60° N. Lat.	Endangered
Northeast Atlantic Ocean	Northeast Atlantic Ocean Basin	Northeast Atlantic Ocean north of the equator, south of 60° N. Lat, east of 40° W. Long, and west of 5°36' W. Long	Endangered
Northwest Atlantic Ocean	Northwest Atlantic Ocean Basin	Northwest Atlantic Ocean north of the equator, south of 60° N. Lat, and west of 40° W. Long	Endangered
South Atlantic Ocean	South Atlantic Ocean	South Atlantic Ocean south of the equator, north of 60° S. Lat, west of 20° E. Long, and east of 67° W. Long	Threatened
South Pacific Ocean	South Pacific Ocean Basin	South Pacific south of the equator, north of 60° S. Lat, west of 67° W. Long, and east of 139° E. Long.	Endangered
Southeast Indo-Pacific Ocean	Southeast Indian Ocean Basin; South Pacific Ocean Basin as far east as 139° E Long	Southeast Indian Ocean south of the equator, north of 60° S. Lat, and east of 80° E. Long; South Pacific Ocean south of the equator, north of 60° S. Lat, and west of 139° E. Long	Endangered
Southwest Indian Ocean	Southwest Indian Ocean Basin	Southwest Indian Ocean north of the equator, south of 30° N. Lat, west of 20° E. Long, and east of 80° E. Long	Threatened

All loggerheads inhabiting the North Pacific Ocean are derived primarily, if not entirely, from Japanese beaches (although low level nesting may occur in areas around the South China Sea). Along the Japanese coast, nine major nesting beaches (greater than 100 nests per season) and six "submajor'' beaches (10–100 nests per season) were identified. Using information collected from these nine beaches Kamezaki *et al.* (2003) found a substantial decline (50–90 percent) in the size of the annual loggerhead nesting population over the last half of the 20th century. Also, nest count data for the last two decades suggests that the North Pacific population is "small" and lacks a robust gene pool when compared to the larger northwest Atlantic and north Indian Ocean loggerhead populations. Small populations are more susceptible to demographic variability which increases their probability of extinction. Available evidence indicates that due to loss of adult and juvenile mortalities from fishery bycatch and, to a lesser degree the loss of nesting habitat, the North Pacific loggerhead population is declining.

In the South Pacific, loggerhead nesting is almost entirely restricted to eastern Australia (primarily Queensland) and New Caledonia, with the majority of nesting occurring in eastern Australia. The total nesting population for Queensland was approximately 3,500 females in the 1976–1977 nesting season (Limpus 1985; Limpus and Reimer, 1994), however, by the 1999-2000 season Limpus and Limpus (2003) estimated this population at less than 500 females. This represents an estimated 50 to 80 percent decline in the number of breeding females at various Australian rookeries up to 1990 (Limpus and Reimer, 1994) and a decline of approximately 86 percent by 1999 (Limpus and Limpus, 2003).

Information from pilot surveys conducted in 2005 in New Caledonia, combined with oral history information collected, suggests a decline in loggerhead nesting with 60-70 loggerheads nesting on the four surveyed New Caledonia beaches during the 2004–2005 nesting season (Limpus *et al.,*2006). Chaloupka and Limpus (2001) determined that the resident non-breeding loggerhead population on coral reefs of the southern Great Barrier Reef in eastern Australia declined at 3 percent per year from 1985 to the late 1990s. The observed decline was hypothesized as a result of recruitment failure, given few anthropogenic impacts and constant high annual survivorship measured at this foraging habitat (Chaloupka and Limpus, 2001). This decline also coincided with a measured decline in new recruits in these foraging areas (Limpus and Limpus, 2003). Available evidence indicates that due to loss of adult and juvenile mortalities from fishery bycatch the South Pacific population is declining.

Loggerhead sea turtles nesting densities in the North Indian Ocean are the largest in the eastern hemisphere with the vast majority of these nests in Oman (Baldwin *et al.,* 2003). Nesting is rare in the rest of the northern Indian Ocean. Nesting surveys and tagging data were used to extrapolate the number of females nesting at Masirah Island during 1977-78 resulting in 19,000 to 60,000 turtles (assuming 100 percent nesting success) and a partial survey of the island in 1991 estimated 23,000 nesters (Baldwin, 1992; Ross, 1979, 1998). Comparing the nesting data collected after 2008 when nesting surveys were standardized at Masirah to the 1977-78 and 1991 yielded an estimate of 20,000-40,000 nesters (assuming 50 percent nesting success). These estimates suggest a decline in the nesting population over the past three decades which is consistent with observations by local rangers. Mortality across all life stages, fishery bycatch and the loss of nesting habitat is likely to cause this population to decline further.

In the southeast Indo-Pacific Ocean, loggerhead nesting is restricted to Western Australia (Dodd, 1988), which is the largest nesting population in Australia (Natural Heritage Trust, 2005 as cited in NMFS and USFWS 2007b). Evidence suggests the nesting population in the Muiron Islands and North West Cape region was depleted before recent beach monitoring programs began although the data are insufficient to determine trends (Nishemura and Nakahigashi, 1990; Poiner *et al.*, 1990; Poiner and Harris, 1996). Juvenile and adult mortality from fishery bycatch presents the greatest threat to this population's probability of extinction.

In the Southwest Indian Ocean, the highest concentration of nesting occurs on the coast of Tongaland, South Africa, where surveys and management practices were instituted in 1963 (Baldwin *et al.,* 2003). Nesting beach data from this region from 1965 to 2008 indicates an increasing nesting population between the first decade of surveys, which documented 500–800 nests annually, and the last 8 years, which documented 1,100–1,500 nests annually (Nel, 2008). These data represent approximately 50 percent of all nesting within South Africa and are believed to be representative of trends in the region. Loggerhead nesting occurs elsewhere in South Africa and Madagascar, but sampling is not consistent and no trend data are available. This population, although small, is increasing but juvenile mortality from fishery bycatch remains a concern.

Loggerheads in the Northwest Atlantic Ocean comprise one of the two largest nesting assemblages in the world and have been identified as the most significant assemblage in the western hemisphere. Data collected over a period of 10 to 23 years indicates that there has been a significant overall decline in nesting numbers (FWS 2008, Witherington *et al* 2009, TEWG 2009). The annual number of nests has been declining for all subpopulations of Northwest Atlantic loggerheads for which there were adequate data available. Available evidence indicates that this population is declining due to juvenile and adult mortality from fishery bycatch. Five nesting subpopulations have been identified in the Northwest Atlantic Ocean (NMFS and USFWS 2008). Their status follows:

(1) Northern U.S. (Florida/Georgia border to southern Virginia). The Northern U.S. subpopulation is the second largest unit within the Northwest Atlantic population and has been declining significantly at 1.3 percent annually since 1983 (NMFS and USFWS, 2008);

(2) Peninsular Florida (Florida/Georgia border south through Pinellas County, excluding the islands west of Key West, Florida). The most significant declining trend has been documented for the Peninsular Florida subpopulation, where nesting declined 26 percent over the 20-year period from 1989–2008, and declined 41 percent over the period 1998–2008 (NMFS and USFWS, 2008; Witherington *et al.*, 2009). This subpopulation represents approximately 87 percent of all nesting effort in the Northwest Atlantic Ocean DPS (Ehrhart *et al.,* 2003);

(3) Dry Tortugas (islands west of Key West, Florida). Data are currently not adequate to assess trends in the annual number of nests for this subpopulation;

(4) Northern Gulf of Mexico (Franklin County, Florida, west through Texas). Data are currently not adequate to assess trends in the annual number of nests for this subpopulation; and

(5) Greater Caribbean (Mexico through French Guiana, the Bahamas, Lesser and Greater Antilles). This is the third largest subpopulation within the Northwest Atlantic population, with the majority of nesting at Quintana Roo, Mexico. TEWG (2009) reported a greater than 5 percent annual decline in loggerhead nesting from 1995–2006 at Quintana Roo.

In the northeastern Atlantic, the Cape Verde Islands support the only large nesting population of loggerheads in the region (Fretey, 2001). Nesting occurs at some level on most of the islands in the archipelago with the largest nesting numbers reported from Boa Vista Island where 833 and 1,917 nests were reported in 2001 and 2002, respectively, and between 1998 and 2002 the local project had tagged 2,856 females (Varo Cruz *et al.*, 2007). More recently, in 2005, about 3,121 females were reported (Lopez-Jurado *et al.*, 2007). Elsewhere in the northeastern Atlantic, loggerhead nesting is non-existent or occurs at very low levels. Population trends could not be determined for the Cape Verde population because of limited data; however, evidence of directed killing of nesting females suggests that this nesting population is under severe pressure and likely significantly reduced from historic levels. Available evidence indicates that this population is declining due to ongoing mortality of mature females and eggs, low hatchling and emergence success and mortality of juveniles and adults from fishery bycatch.

Nesting occurs throughout the central and eastern Mediterranean and sporadic nesting has been reported in the western Mediterranean, however, the vast majority of nesting (greater than 80 percent) occurs in Greece and Turkey (Margaritoulis *et al.*, 2003). The documented annual nesting of loggerheads in the Mediterranean averages about 5,000 nests (Margaritoulis *et al.*, 2003). There is no discernible trend in nesting at the two longest monitoring projects in Greece, Laganas Bay (Margaritoulis, 2005) and southern Kyparissia Bay (Margaritoulis and Rees, 2001 as cited in NMFS and USFWS 2007b). However, nesting at two beaches (Rethymno Beach, which accounts for approximately 7 percent of all documented loggerhead nesting in the Mediterranean) and Fethiye Beach in Turkey (which accounts for 10 percent of nesting in Turkey), show a declining trend in 1990–2004 and 1993-2004, respectively (Ilgaz *et al*. 2007 as cited in NMFS and USFWS 2007b, Margaritoulis *et al.*, 2009). Juvenile and adult mortality from fishery bycatch and the loss of nesting habitat, eggs and hatchlings remain a concern for this population.

In the South Atlantic nesting occurs primarily along the mainland coast of Brazil. Prior to 1980, loggerhead nesting populations in Brazil were considered depleted, however, an increasing trend has been reported from 1988 through 2003 on beaches representing more than 75 percent of all loggerhead nesting in Brazil. A total of 4,837 nests were reported from these survey beaches for the 2003–2004 nesting season (Marcovaldi and Chaloupka, 2007). Juvenile mortality from fishery bycatch remains a concern for this population.

Diving Behavior

Studies of loggerhead diving behavior indicate varying mean depths and surface intervals, depending on whether they were located in shallow coastal areas (short surface intervals) or in deeper, offshore areas (longer surface intervals). The maximum recorded dive depth for a post-nesting female was 211-233 meters, while mean dive depths for both a post-nesting female and a subadult were 9-22 meters. Routine dive times for a post-nesting female were between 15 and 30 minutes, and for a subadult, between 19 and 30 minutes (Sakamoto *et al.* 1990 *cited in* Lutcavage and Lutz 1997). Two loggerheads tagged by Hawai'i-based longline observers in the North Pacific and attached with satellite-linked dive recorders were tracked for about 5 months. Analysis of the dive data indicates that most of the dives were very shallow - 70% of the dives were no deeper than 5 meters. In addition, the loggerheads spent approximately 40% of their time in the top meter and nearly all of their time at depths shallower than 100 meters. On 5% of the days, the turtles dove deeper than 100 meters; the deepest daily dive recorded was 178 meters (Polovina *et al.* 2003).

Polovina *et al.* (2004) reported that tagged turtles spent 40 percent of their time at the surface and 90 percent of their time at depths shallower than 40 meters. On only five percent of recorded dive days loggerheads dove to depths greater than 100 meters at least once. In the areas that the loggerheads were diving, there was a shallow thermocline at 50 meters. There were also several strong surface temperature fronts the turtles were associated with, one of 20°C at 28°N latitude and another of 17°C at 32°N latitude.

Hearing

The information on loggerhead turtle hearing is very limited. Bartol *et al.* (1999) studied the auditory evoked potential of loggerhead sea turtles that had been captured in pound nets in tributaries to the Chesapeake Bay in Maryland and Virginia and concluded that loggerhead sea turtles had most sensitive hearing between 250 and 1000 Hz, with rapid decline above 1000 Hz (Bartol *et al.* 1999). This is similar to the results produced by Ridgway *et al.* (1969) who studied the auditory evoked potentials of three green sea turtles (in air and through mechanical stimulation of the ear). They concluded that the maximum sensitivity of green sea turtles occurred from 300 to 400 Hz with rapid declines for tones at lower and higher frequencies. They reported an upper limit for cochlear potentials without injury of 2000 Hz and a practical limit of about 1000 Hz.

These hearing sensitivities are similar to the hearing sensitivities reported for two terrestrial species: pond turtles (*Pseudemys scripta*) and wood turtles (*Chrysemys inscuplta*). Pond turtles are reported to have best hearing responsiveness 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 have sensitivities up to about 500 Hz, followed by a rapid decline above 1000 Hz and almost no responses beyond 3000 or 4000 Hz (Peterson 1966).

3.15. Designated Critical Habitat for North Atlantic Right Whales

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*. 1990), 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).

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 1982).

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 April 1 to June 30 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 June 3, 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.

4.0 Environmental Baseline

By regulation, environmental baselines for biological 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 which are contemporaneous with the consultation in process (50 CFR 402.02). The environmental baseline for this biological opinion includes the effects of several activities that affect the survival and recovery of endangered whales and threatened and endangered sea turtles in the action area.

A number of human activities have contributed to the current status of populations of large whales and sea turtles in the action area. Some of those activities, most notably commercial whaling, occurred extensively in the past, ended, and no longer appear to affect these whale populations, although the effects of these reductions likely persist today. Other human activities are ongoing and appear to continue to affect whale and sea turtles populations in the Action Areas for this consultation. The following discussion summarizes the principal phenomena that are known to affect these endangered whales and threatened and endangered sea turtles in the Action Areas.

Natural Mortality

The sources of natural mortality discussed in the species-specific narratives from the preceding section of these Opinions affect endangered and threatened whales and sea turtles in the Action Areas for this consultation as well. For example, the various habitat types sea turtles occupy along the Atlantic coast of the United States exposes these sea turtles to a wide variety of natural and anthropogenic threats. The Atlantic beaches on which loggerhead sea turtles nest and the nests themselves are threatened by hurricanes and tropical storms as well as the storm surges, sand accretion, and rainfall that are associated with hurricanes. For example, in 1992, all of the eggs over a 90-mile length of coastal Florida were destroyed by storm surges on beaches that were closest to the eye of Hurricane Andrew (Milton *et al.* 1994). Hatchling sea turtles are hunted by predators like herons, gulls, dogfish, and sharks. Adult sea turtles are also killed by sharks and other large, marine predators and are killed by cold stunning and exposure to biotoxins.

Human-Induced Mortality

Commercial Whaling and Subsistence Hunting

Large whale population numbers in the proposed action areas have historically been impacted by commercial exploitation, mainly in the form of whaling. Prior to current prohibitions on whaling, such as the International Whaling Commission's 1966 moratorium, most large whale species had been depleted to the extent it was necessary to list them as endangered under the ESA of 1966. Nevertheless, fin whales are still hunted in subsistence fisheries off West Greenland. In 2004, 5 males and 6 females were killed and landed; 2 other fin whales were struck and lost in the same year. In 2003 2 males and 4 females were landed and 2 other fin whales were struck and lost (IWC 2005). Between 2003 and 2007, the IWC set a catch limit of up to 19 fin whales in this subsistence fishery (IWC 2005), however, the IWC's Scientific Committee recommended limiting the number of fin whale killed in this fishery to 1 to 4 individuals until accurate population estimates are produced.

Ship Strikes

As discussed in the *Status of the Species* narratives for several of the whales that are considered in these Opinions, ship strikes pose significant threats to populations of endangered whales along the Atlantic coast, particularly North Atlantic right whales. Based on estimates contained in the U.S. Coast Guard's database on vessel arrivals in 26 port areas in 2003 and 2004, 25,532 vessels arrived at ports along the East Coast of the United States. By 2004, the number of arrivals increased by 7.3 percent, to 27,385 arrivals. Container ships represented most of the arrivals with 8,623 arrivals in 2003 (about one third of all arrivals) and 8,886 arrivals in 2004 (a little under one third of all arrivals). Tank ships were the second-most frequent type of vessel, with 5,439 arrivals in 2003 and 5,513 in 2004. Other vessel types include bulk carriers (3,149 arrivals in 2004), ro-ro cargo vessels (3,054 arrivals in 2004), and general cargo vessels (1,843 arrivals in 2004). The mid-Atlantic region of the Atlantic coast had the highest levels of vessel traffic of the three regions on the Atlantic Coast, with 21,657 vessel arrivals in 2004. The Southeastern United States has the second-highest volume of vessel traffic on the East Coast, with 4,440 vessel arrivals in 2004, followed by the northeastern region which had 2,570 arrivals in 2004. In both of these years, the most active region was the Port of New York/New Jersey, with 5,426 and 5,550 vessel arrivals in 2003 and 2004, respectively. The Chesapeake Bay port region was second only to the Port of New York, with 4,486 and 4,875 arrivals in 2003 and 2004, respectively. Other port regions with more than 2,000 vessel arrivals in 2004 include the Southeastern United States (4,315 vessel arrivals), the Delaware Bay region (2,661 vessel arrivals), and the Block Island Sound region (2,563 vessel arrivals). In terms of single port areas, New York City had the most vessel arrivals (5,550 arrivals) in 2004, followed by Hampton Roads (2,834 arrivals), Philadelphia (2,661 arrivals), Jacksonville (2,517 arrivals), Savannah (2,474 arrivals), Charleston (2,473 arrivals), Baltimore (2,041 arrivals), and Port Canaveral (1,062 arrivals).

About 302 Federal vessels have been estimated to operate in waters off the East Coast, although all of these vessels probably do not operate at one time or in the same area. The percentage of time these vessels spend at sea varies with the specific mission and objectives of each agency. For example, a study conducted on Navy vessel traffic estimated that of the Navy's 121 East Coast vessels, there are 12 vessels on the East Coast within 200 nm (370.4 km) of shore at any given time (Filadelfo 2001).

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 percent) of the recorded ship strikes from 1975 to 2002 occurred off the coasts of the northeastern United States and Canada, while the mid- Atlantic and southeastern areas each accounted for 22 percent (Jensen and Silber 2003).

In particular, ship strikes represent the greatest threat to the continued existence of North Atlantic right whales: 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 2001, NMFS 2005b).

Table 10. East Coast Vessel Arrivals by Vessel Type, 2003 and 2004 (data from NOAA 2008)

Vessel Type	2003	2004
Bulk carrier	2,743	3,149
Combination carrier	150	106
Containership	8,623	8,886
Freight barge	243	274
General cargo vessel	1,752	1,843
Passenger vessel	1,229	1,666
Refrigerated cargo vessel	621	548
Ro-Ro cargo vessel	3,107	3,054
Tank barge	1,127	1,492
Tank ship	5,439	5,513
Towing vessel	416	745
Other[1]	82	109
Total	**25,532**	**27,385**

[1] Includes fishing vessels, industrial vessels, research vessels, and school ships.
Source: Nathan Associates Inc., 2005.

Table 11. Federal Vessels greater than 65 feet in length along the US East Coast (data from NOAA 2008)

Agency	Total Number	Number on East Coast
U.S. Navy	261[a]	121
Maritime Adminisration (National Defense Reserve Fleet)	230	55[b]
U.S. Coast Guard	250	108[c]
National Science Foundation	25	5
NOAA	18	6
U.S. Army Corps of Engineers (Dredges – FY07 Operations)	11	4[d]

EPA	1	1
Department of the Interior Agencies (MMS, FWS, NPS, USGS)	2	2[e]
Total Federal vessels	**798**	**302**

Based on records collected between 1970 and 1999, about 60 percent of the right whales struck by ships along the Atlantic Coast of the United States, 60 percent occurred in waters off the northeast states and 20 percent occurred in waters off the mid-Atlantic or southeast states (Knowlton and Kraus 2001). Over the same time interval (1970 to 1999), these authors identified 25 (44.6 percent) unconfirmed serious injuries and mortalities from ship strikes and 31 (55.4 percent) 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 35.5 percent) of all confirmed right whale mortalities (a confirmed mortality is one observed under specific conditions defined by NMFS).[10] Of the remaining mortalities that have been confirmed, three (6.7 percent) were due to entanglement in fishing gear; 13 (28.9 percent) were neonate deaths; and another 13 (28.9 percent) were deaths of non-calf animals from unknown causes (Knowlton and Kraus 2001).

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 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).

Glass *et al*. (2008) reported that there were 54 determinations of right whale mortality and serious injury between 2002 and 2006. Out of 21 verified right whale mortalities, 10 were from ship strikes and 3 were from entanglement. Entanglement was identified as the cause of four recorded serious injuries. There were also two documented serious injuries from ship strikes (Glass *et al*. 2008).

A summary paper on ship collisions and whales by Laist *et al.* (2001) reported that out of 28 recorded collisions resulting in lethal or severe injuries to whales in which vessel speed was known, 89 percent involved vessels traveling at 14 knots or faster and the remaining 11 percent involved vessels traveling at

10 There are four main criteria used to determine whether serious injury or mortality resulted from ship strikes: (1) propeller cut(s) or gashes that are more than approximately 8 cm in depth; (2) evidence of bone breakage determined to have occurred premortem; (3) evidence of haematoma or haemorrahaging; and (4) the appearance of poor health in the ship-struck animal (Knowlton and Kraus 2001).

10 to 14 knots. None occurred at speeds below 10 knots. The IWC database of vessel collisions identified 83 events where speed was recorded; the majority of serious injuries and mortalities occurred within a similar range of 15 to 20 knots (Van Waerbeek and Leaper 2008). With regard to the severity of injuries at increasing speeds, Pace and Silber (2005) found a predicted 45 percent chance of death or serious injury at 10 knots. Vanderlaan and Taggart (2007) came to a similar conclusion, determining that the probability of death from a collision was approximately 35-40 percent at 10 knots.

North Atlantic right whales appear to be either unable to detect approaching vessels or, while right whales are engaged in behavioral activities — for example, feeding, nursing, or mating — they ignore the visual or acoustic cues those vessels produce. Because right whales are buoyant and are slow swimmers, they may not be able to avoid oncoming vessels even if they are aware of its approach. When the vulnerability of right whales to ship strikes is combined with the density of ship traffic within the distribution of right whales, ship strikes seem almost inevitable.

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 2003). Vessel speed (if recorded) at the time of a large whale collision has ranged from 2 to 51 knots (Jensen and Silber, 2003). Vessels can be damaged during ship strikes (occasionally, collisions with large whales have even harmed or killed humans on board the vessels); of 13 recorded vessels that reported damages from a strike, all were traveling at a speed of at least 10 knots (Jensen and Silber 2003).

Entrapment and Entanglement in Commercial Fishing Gear

Several commercial fisheries operate in the Action Area for this consultation. The fisheries that have the most significant demographic effect on sea turtles are the shrimp trawl fisheries conducted off the southeast United States (from North Carolina to the Atlantic coast of Florida) and Gulf of Mexico (from the Gulf coast of Florida to Texas). Although participants in these 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 percent, each year these fisheries are expected to capture about 185,000 sea turtles each year and kill about 5,000 of the turtles captured. Loggerhead sea turtles account for most of this total: each of these fisheries are expected to capture about 163,000 loggerhead sea turtles, killing almost 4,000 of them. 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 2002).

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, which operate off the coast South Carolina and Georgia (with the exception of waters off Florida and southernmost Georgia that are closed to the longline component of these fisheries) and the Gulf of Mexico, 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.

Between 1986 and 1995, this fishery captured and killed 1 northern right whale, 2 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 sea turtles in the process (the latter estimate does not include 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 sea turtles in the process.

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, sea turtles are captured and killed in several other Federal fisheries that operate along the Atlantic coast (see Table 8), although most of these fisheries capture and kill fewer sea turtles than the fisheries discussed in the preceding narratives. Of all the factors that influenced NMFS' decision to list sea turtles as threatened or endangered, the most significant sources of injury or mortality of juvenile, subadult, and adult sea turtles are those associated with commercial fishing.

The fisheries discussed in this section of these Opinions are expected to continue into the foreseeable future at levels of effort that are roughly equivalent to current levels. As a result, we expect the number of sea turtles that are captured and killed in these fisheries to continue for the foreseeable future. These estimates mean that, every five years, more than 800,000 loggerhead sea turtles would be captured in these fisheries, with more than 23,000 of them dying as a result; about 19,000 leatherback sea turtles would be captured, with about 1,500 of them dying as a result; about 95,000 green sea turtles would be captured, with about 2,900 of them dying; and about 3,200 hawksbill sea turtles being captured and killed.

Habitat Degradation

Chronic exposure to the neurotoxins associated with paralytic shellfish poisoning from zooplankton prey has been shown to have detrimental effects on marine mammals. Estimated ingestion rates are sufficiently high to suggest that the PSP toxins are affecting marine mammals, possibly resulting in lower respiratory function, changes in feeding behavior and a lower reproduction fitness (Durbin *et al.* 2002). Other human activities, including discharges from wastewater systems, dredging, ocean dumping and disposal, aquaculture and additional impacts from coastal development are also known to impact marine mammals and their habitat.

Water Pollution. Coastal runoff and river discharges carry large volumes of petrochemical and other contaminants from agricultural activities, cities and industries into the Gulf of Mexico. The coastal waters of the Gulf of Mexico have more sites with high contaminant concentrations than other areas of the coastal United States, due to the large number of waste discharge point sources. Although these contaminant concentrations do not likely affect the more pelagic waters of the action area, the species of turtles analyzed in this biological opinion travel between nearshore and offshore habitats and may be exposed to and accumulate these contaminants during their life cycles. The contaminants that pose potential risks to the health of cetaceans, particularly North Atlantic right whales (O‘ Shea *et al*. 1994; Reijnders *et al*. 1999), include persistent organic pollutants (Polychlorinated biphenyls, polychlorinated dibenzo-p-dioxins, polychlorinated dibenzofurans, dichloro-diphenyl-trichloroethane, chlordanes, and hexachlorocyclohexane); flame retardants (Polybrominated diphenyl ethers); plasticizers (Phthalate esters); surfactants (Alkyphenol ethoxylates such as nonylphenoletoxylates); new-era pesticides and herbicides; municipal and industrial effluents (including endocrine-disrupting compounds such as synthetic estrogens, natural hormones, pulp byproducts); anti-fouling agents (rganotins and replacement compounds); dielectric fluids: PCB replacements (e.g., polychlorinated napthalenes, polybrominated biphenyls); aquaculture-related chemicals (such as antibiotics and pesticides); and metals such methyl mercury.

Concentrations of organochlorines, including DDT, PCBs, HCHs, aldrin, and dieldrin, have been observed in many species of marine mammals, including right whales. PCBs have been found in samples of right whale blubber (Weisbrod *et al*. 2000) and, at low levels, in zooplankton sampled from Cape Cod Bay (Reeves *et al*. 2001). PCBs, DDT, and other organochlorines have been detected in northern right whale samples from the Bay of Fundy, Browns, and Baccarro Banks (Woodley *et al.* 1991 *in* NMFS 2005a). However, the available information does not allow us to determine whether endangered or threatened species are exposed to concentrations to these compounds that are sufficiently high to alter their ecology or reduce the performance of individuals.

Another source of pollutants that may have an effect on right whale health and reproduction are biotoxins. Biotoxins are transferred to right whales through ingestion of copepods, such as *C. finmarchicus*, which consume paralytic shell-fish toxin-producing dinoflagellates such as *Alexandrium* and similar organisms (Doucette *et al*. 2006). Biotoxins are highly toxic compounds produced by harmful algal blooms.[11] Five major classes of biotoxins are associated with harmful algal blooms: saxitoxins (responsible for paralytic

[11] Algae are photosynthetic plant-like organisms that live in water. Most species of algae or phytoplankton are not harmful and serve as the energy producers at the base of the food chain. Occasionally, the algae grow very fast or "bloom" and accumulate into dense, visible patches near the surface of the water. "Red Tide" is a common name for this situation, whereby certain phytoplankton species contain redish pigments and bloom such that the waters appear red (NMFS 2005a).

shellfish poisoning); brevatoxins (responsible for neurotoxic shellfish poisoning in the southeastern United States); domoic acid (amnesic shellfish poisoning); okasdaic acid and dinophysistoxins (diarrhetic shellfish poisoning); and ciguatoxins. The first three of these classes have been implicated in marine mammal mortality events (Reeves *et al*., 2001).

An extensive review of environmental contaminants in turtles has been conducted by Meyers-Schöne and Walton (1994); however, most of this information relates to freshwater species. High concentrations of chlorobiphenyls and organochlorine pesticides in the eggs of the freshwater snapping turtle, *Chelydra serpentina*, have been correlated with population effects such as decreased hatching success, increased hatchling deformities and disorientation (Bishop *et al.* 1991 1994).

Very little is known about baseline levels and physiological effects of environmental contaminants on marine turtle populations (Witkowski and Frazier 1982, Bishop *et al*. 1991). There are a few isolated studies on organic contaminants and trace metal accumulation in green and leatherback sea turtles (Davenport and Wrench 1990, Aguirre *et al.* 1994). Mckenzie *et al.* (1999) measured concentrations of chlorobiphenyls and organochlorine pesticides in marine turtle tissues collected from the Mediterranean (Cyprus, Greece) and European Atlantic waters (Scotland) between 1994 and 1996. Omnivorous logger-head turtles had the highest organochlorine contaminant concentrations in all the tissues sampled, including those from green and leatherback turtles. It is thought that dietary preferences were likely to be the main differentiating factor among species. Decreasing lipid contaminant burdens with turtle size were observed in green turtles, most likely attributable to a change in diet with age. Sakai *et al.* (1995) found the presence of metal residues occurring in loggerhead turtle organs and eggs. More recently, Storelli *et al.* (1998) analyzed tissues from twelve loggerhead sea turtles stranded along the Adriatic Sea (Italy) and found that characteristically, mercury accumulates in sea turtle livers while cadmium accumulates in their kidneys, as has been reported for other marine organisms like dolphins, seals and porpoises by Law *et al.* (1991). Keller *et al.* (2006) found that chronic exposure of sea turtles to organochlorine contaminants (such as PCBs and pesticides) may modulate the immune response in these animals by suppressing innate immunity and enhancing certain lymphocyte activity. Polycyclic aromatic hydrocarbons (PAHs) have been documented to affect embryo development in other turtle species (Van Meter *et al.* 2006). More research is needed on the short- and long-term health and fecundity effects of chlorobiphenyl, organochlorine, and heavy metal accumulation in sea turtles.

The impacts on these activities are difficult to measure. Some researchers have correlated contaminant exposure to possible adverse health effects in marine mammals. Studies of captive harbor seals have demonstrated a link between exposure to organochlorines (*e.g.*, DDT, PCBs, and PAHs) and immunosuppression (Ross *et al*. 1995, Harder *et al.* 1992, De Swart *et al.* 1996). Organochlorines are chemicals that tend to bioaccumulate through the food chain, thereby increasing the potential of indirect exposure to a marine mammal via its food source. During pregnancy and nursing, some of these contaminants can be passed from the mother to developing offspring. Contaminants like organochlorines do not tend to accumulate in significant amounts in invertebrates, but do accumulate in fish and fish-eating animals. Thus, contaminant levels in piscivorous odontocetes have been reported to be one to two orders of magnitude higher compared to planktivorous mysticetes (Borell, 1993, O'Shea and Brownell 1994, O'Hara and Rice 1996, O'Hara *et al.* 1999).

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.

Anthropogenic Noise. The marine mammals that occur in the action area are regularly exposed to several sources of natural and anthropogenic sounds. Anthropogenic noises that could affect ambient noise arise from the following general types of activities in and near the sea, any combination of which can contribute to the total noise at any one place and time. These noises include transportation, dredging, construction; oil, gas, and mineral exploration in offshore areas; geophysical (seismic) surveys; sonars; explosions; and ocean research activities (Richardson *et al.* 1995).

Noise in the marine environment has received a lot of attention in recent years and is likely to continue to receive attention in the foreseeable future. Several investigators have argued that anthropogenic sources of noise have increased ambient noise levels in the ocean over the last 50 years (Jasny *et al.* 2005; NRC 1994, 1996, 2000, 2003, 2005; Richardson *et al.* 1995). Much of this increase is due to increased shipping as ships become more numerous and of larger tonnage (NRC 2003). Commercial fishing vessels, cruise ships, transport boats, airplanes, helicopters and recreational boats all contribute sound into the ocean (NRC 2003). The military uses sound to test the construction of new vessels as well as for naval operations. In some areas where oil and gas production takes place, noise originates from the drilling and production platforms, tankers, vessel and aircraft support, seismic surveys, and the explosive removal of platforms (NRC 2003). 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.* 1995). 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 1986, Hall 1982, Krieger and Wing 1984), but the long-term effects, if any, are unclear or not detectable. Carretta *et al.* (2001) and Jasny *et al.* (2005) identified the increasing levels of anthropogenic noise as a habitat concern for whales and other cetaceans because of its potential effect on their ability to communicate.

Surface shipping is the most widespread source of anthropogenic, low frequency (0 to 1,000 Hz) noise in the oceans (Simmonds and Hutchinson 1996). The Navy estimated that the 60,000 vessels of the world's merchant fleet annually emit low frequency sound into the world's oceans for the equivalent of 21.9 million days, assuming that 80 percent of the merchant ships are at sea at any one time (U.S. Navy 2001). The radiated noise spectrum of merchant ships ranges from 20 to 500 Hz and peaks at approximately 60 Hz. Ross (1976) has estimated that between 1950 and 1975 shipping had caused a rise in ambient ocean noise levels of 10 dB. He predicted that this would increase by another 5 dB by the beginning of the 21st century. NRC (1997) estimated that the background ocean noise level at 100 Hz has been increasing by about 1.5 dB per decade since the advent of propeller-driven ships.

Michel *et al.* (2001) suggested an association between long-term exposure to low frequency sounds from shipping and an increased incidence of marine mammal mortalities caused by collisions with shipping. At lower frequencies, the dominant source of this noise is the cumulative effect of ships that are too far away to be heard individually, but because of their great number, contribute substantially to the average noise background.

US Navy Activities. In 1997, NMFS issued a biological opinion on Navy training activities within and in the vicinity of the Atlantic Ocean right whale critical habitat off of the coasts of Georgia and Florida (NMFS 1997). That Opinion concluded that Navy training activities were not likely to jeopardize the continued existence of North Atlantic right whales and other endangered or threatened species or result in the destruction or adverse modification of critical habitat that had been designated in the action area for that consultation.

In the late 1990s, the U.S. Navy implemented several new mitigation measures that were designed to protect right whales. Because of these mitigation measures, NMFS concluded that current Navy operations out of Mayport, Florida were not likely to jeopardize the continued existence of endangered or threatened species under NMFS' jurisdiction (NMFS 1997).

Vessel operations and ordnance detonations adversely affect listed species of sea turtles and whales. 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). The Navy ship-shock trials for the USS WINSTON S CHURCHILL were conducted in the proposed Action Area, although the U.S. Navy employed a suite of measures that appeared to protect marine mammals and sea turtles from being exposed to shock waves produced by the underwater detonations associated with the trial (Clarke and Norman 2005).

Between July 2006 and July 2008, the U.S. Navy conducted several Composite Training Unit or Joint Task Force Exercises in and seaward of the Cherry Point and Jacksonville-Charleston Operating Areas. These exercises included antisubmarine warfare training events that employed between 49 and 355 hours of mid-frequency active sonar and deployed between 15 and 170 DICASS sonobuoys. All but two of these exercises were conducted during the summer (the exceptions were a Expeditionary Strike Group Composite Training Unit exercise conducted from mid-May to the first of June 2007 and a Carrier Strike Group Joint Task Force exercise conducted from late April to mid-May 2008), which would have avoided interactions with North Atlantic right whales and most other large cetaceans. The actual number of marine animals that might have been exposed to mid-frequency active sonar during these exercises, and their responses to any exposure, remains unknown; however, no marine animals were reported to have been struck or killed during any of these exercises

In August and September 2008, the U.S. Navy conducted a ship shock trial on the MESA VERDE in waters east of Jacksonville, Florida, using High Blast Explosive (HBX-1) for the detonations (U.S. Navy 2008d). NMFS' biological opinion on the ship shock trial expected up to 36 sea turtles to be injured as a result of the ship shock trial and up to 1,727 turtles to be harassed as a result of their behavioral responses to the underwater detonations. The after action report for the ship shock trial could neither refute nor confirm these estimated number of animals that might have been harassed by the trials; however, surveys associated with the trial did not detect any dead or injured marine mammals or sea turtles during the shock trial event or during post-mitigation monitoring. In addition, no marine mammal or sea turtle stranding events have been attributed to the shock trial.

In 2002, the U.S. Navy established protective measures for North Atlantic right whales for all Atlantic Fleet activities occurring in the Northeast Operating Area. In December 2004, the U.S. Navy issued further guidance for all Fleet ships to increase awareness of right whale migratory patterns and implement additional protective measures along the mid-Atlantic coast, including areas where ships transit between southern New England and northern Florida. The Navy worked with NMFS to identify seasonal patterns of right whale occurrence in six major sections of the mid-Atlantic coast, paying particular attention to port and coastal areas where efforts to manage vessel traffic might be most appropriate. The Navy's resulting guidance directed Navy personnel to exercise extreme caution and operate at slow, safe speeds within 20 nautical mile arcs of specified coastal and port reference points. The guidance reiterated previous instructions that Navy ships post two lookouts, one of whom must have completed marine mammal recognition training, and emphasized the need for utmost vigilance in performance of these watchstander duties.

Deep Water Ambient Noise. Urick (1983) provided a discussion of the ambient noise spectrum expected in the deep ocean. Shipping, seismic activity, and weather are primary causes of deep-water ambient noise. Noise levels between 20 and 500 Hz appear to be dominated by distant shipping noise that usually exceeds wind-related noise. Above 300 Hz, the level of wind-related noise might exceed shipping noise. Wind, wave, and precipitation noise originating close to the point of measurement dominate frequencies from 500 to 50,000 Hz. The frequency spectrum and level of ambient noise can be predicted fairly accurately for most deep-water areas based primarily on known shipping traffic density and wind state (wind speed, Beaufort wind force, or sea state) (Urick 1983). For frequencies between 100 and 500 Hz, Urick (1983) has estimated the average deep water ambient noise spectra to be 73 to 80 dB for areas of heavy shipping traffic and high sea states, and 46 to 58 dB for light shipping and calm seas.

Shallow Water Ambient Noise. In contrast to deep water, ambient noise levels in shallow waters (i.e., coastal areas, bays, harbors, etc.) are subject to wide variations in level and frequency depending on time and location. The primary sources of noise include distant shipping and industrial activities, wind and waves, and marine animals (Urick 1983). At any given time and place, the ambient noise level is a mixture of these noise types. In addition, sound propagation is also affected by the variable shallow water conditions, including the depth, bottom slope, and type of bottom. Where the bottom is reflective, the sound levels tend to be higher than when the bottom is absorptive.

Commercial and Private Marine Mammal Watching

In addition to the federal vessel operations, private and commercial shipping vessels, vessels (both commercial and private) engaged in marine mammal watching also have the potential to impact whales in the proposed action area. A recent study of whale watch activities worldwide has found that the business of viewing whales and dolphins in their natural habitat has grown rapidly over the past decade into a billion dollar ($US) industry involving over 80 countries and territories and over 9 million participants (Hoyt 2001). In 1988, a workshop sponsored by the Center for Marine Conservation and the NMFS was held in Monterey, California to review and evaluate whale watching programs and management needs (CMC and NMFS 1988). That workshop produced several recommendations for addressing potential harassment of marine mammals during wildlife viewing activities that include developing regulations to restrict operating thrill craft near cetaceans, swimming and diving with the animals, and feeding cetaceans in the wild.

Since then, NMFS has promulgated regulations at 50 CFR 224.103 that specifically prohibit: (1) the negligent or intentional operation of an aircraft or vessel, or the doing of any other negligent or intentional act which results in disturbing or molesting a marine mammal; (2) feeding or attempting to feed a marine mammal in the wild; and (3) approaching humpback whales in Hawai‘i and Alaska waters closer than 100 yards (91.4 m). In addition, NMFS launched an education and outreach campaign to provide commercial operators and the general public with responsible marine mammal viewing guidelines which in part state that viewers should: (1) remain at least 50 yards from dolphins, porpoise, seals, sea lions and sea turtles and 100 yards from large whales; (2) limit observation time to 30 minutes; (3) never encircle, chase or entrap animals with boats; (4) place boat engine in neutral if approached by a wild marine mammal; (5)

leave the water if approached while swimming; and (6) never feed wild marine mammals. In January 2002, NMFS also published an official policy on human interactions with wild marine mammals which states that: "*NOAA Fisheries cannot support, condone, approve or authorize activities that involve closely approaching, interacting or attempting to interact with whales, dolphins, porpoises, seals or sea lions in the wild. This includes attempting to swim with, pet, touch or elicit a reaction from the animals.*"

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. One concern is that animals may become more vulnerable to vessel strikes once they habituate to vessel traffic (Swingle *et al.* 1993; Wiley *et al.* 1995). Another concern is that preferred habitats may be abandoned if disturbance levels are too high.

Several investigators have studied the effects of whale watch vessels on marine mammals (Amaral and Carlson 2005; Au and Green 2000, Cockeron 1995, Erbe 2002, Félix 2001, Magalhães *et al.* 2002, Richter *et al.* 2003, Scheidat *et al.* 2004, Simmonds 2005, Watkins 1986, Williams *et al.* 2002). The whale's behavioral responses to whale watching vessels depended on the distance of the vessel from the whale, vessel speed, vessel direction, vessel noise, and the number of vessels. The whales' responses changed with these different variables and, in some circumstances, the whales did not respond to the vessels, but in other circumstances, whales changed their vocalizations, surface time, swimming speed, swimming angle or direction, respiration rates, dive times, feeding behavior, and social interactions.

Recovery Actions

Several agencies have engaged in a variety of actions that are designed to reduce the effects of human activities on endangered and threatened species in the Action Area. In 1993, NMFS formed the Southeast Implementation Team for the Right Whale Recovery Plan to address the goals of the Right Whale Recovery Plan within NMFS' Southeast Region. The recovery plan has identified entanglement in fishing gear and ship collisions as the two major direct human impacts affecting both species. Habitat degradation through pollution or other major habitat alteration processes caused by either human sources (discharge or disposal in the marine environment) or resource management activities (fishery or minerals management) is also identified as a major indirect impact requiring attention.

In 1993, the Government of Canada recognized the importance of a portion of the Roseway Basin by designating it as a Right Whale Conservation Area. This basin, which is about 20 nautical miles south of Cape Sable Island Nova Scotia, is one of only two known areas where large numbers of North Atlantic right whales gather on a seasonal basis in Canadian waters.

In 1999, the U.S. Coast Guard implemented a Mandatory Ship Reporting System that requires vessels larger than 300 gross registered tons (Department of the Navy ships are exempt) to report their location, course, speed, and destination upon entering the nursery and feeding areas of the right whale. At the same time, ships receive information on locations of right whale sightings, in order to avoid collisions with the animals. In the southeastern United States, the reporting system is from November 15 through April 15 of each year; the geographical boundaries include coastal waters within roughly 46 kilometers (km) (25 nautical miles [nm]) of shore along a 167 km (90 nm) stretch of the Atlantic coast in Florida and Georgia. In the northeastern United States, the reporting system is year-round and the geographical boundaries include the waters of Cape Cod Bay, Massachusetts Bay, and the Great South Channel east and southeast of Massachusetts; it includes all of Stellwagen Bank National Marine Sanctuary.

An Early Warning System for right whales has been operational in areas of the southeastern U.S. for several years. This system identifies the known location of right whales within and adjacent to the winter calving area from Savannah, Georgia, to Sebastian Inlet, Florida, from 1 December through 31 May (when right whales are assumed to occur in these waters) and provides this information to mariners. This system has successfully diverted shipping to avoid right whales on several occasions, thus decreasing the threat of vessel collisions.

On 1 July 2007, NOAA and the U.S. Coast Guard implemented a shift in the Traffic Separation Scheme servicing Boston to reduce the threat of vessel collisions with right whales and other whale species. The realignment is expected to result in a 58% reduction in the risk of ship strikes to right whales, and an 81% risk reduction in ship strikes of other large whale species occurring in the area.

In 2002, the International Maritime Organization unanimously adopted a Canadian proposal to amend the Bay of Fundy Traffic Separation Scheme to reducing the relative probability of a ship strike in the Roseway Basin by about 80 percent. The Canadian Government proposed establishing a seasonal “Area to be Avoided” in the Roseway Basin, which would apply to ships of 300 gross tonnage or greater, during the seven-month period from June 1 to December 31 when the largest percentage of Right Whales is known to be in the area and when the risk of ship strikes is greatest. The International Maritime Organization’s Maritime Safety Committee adopted Canada's proposal at its 83rd session in Copenhagen Denmark 3-12 October 2007; the newly designated recommended seasonal “Area to be Avoided” took effect six months after it was adopted and was in place prior to the seasonal return of the Right Whales to the Roseway Basin in the spring and summer of 2008.

In October 2008, NMFS established regulations that implement a 10-knot speed restriction for all vessels 65 ft (19.8 m) or longer in certain locations along the east coast of the U.S. Atlantic seaboard at certain times of the year to reduce the likelihood of deaths and serious injuries to endangered North Atlantic right whales that result from collisions with ships. Evidence suggests that the likelihood of death and serious injury to large whales struck by ships is related to ship speed. The regulations limit ship speed during times and in areas where relatively high right whale and ship densities overlap near a number of U.S. east coast ports, at calving/nursery areas in waters off Georgia and Florida, and in New England waters.

The Impact of the Baseline on Listed Resources

Although 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 as well as 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, the impact of those activities on the status, trend, or the demographic processes of threatened and endangered species remains largely unknown.

Impact on Endangered Whales. Historically, commercial whaling had occurred in the action area and had caused all of the large whales to decline to the point where the whales faced risks of extinction that were high enough to list them as endangered species. Since the end of commercial whaling, the primary threat to these species has been eliminated; however, population sizes of the endangered whales along the Atlantic Coast of the United States still remain at fractions of the population sizes that are estimated to have existed prior to whaling. Nevertheless, populations of species like humpback whales have increased substantially from post-whaling populations levels and appear to be recovering despite the number of individuals that have been killed or injured as a result of 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 along the Atlantic Ocean, although 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 their populations.

Recent attention has focused on the emergence of a wide number of anthropogenic sound sources in the action area and their role as an 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 remains uncertain.

Gauthier and Sears (1999), Weinrich *et al.* (1991, 1992), Clapham and Mattila (1993), Clapham *et al.* (1993) 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 have 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.* (1981) 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 (1986) and Bauer and Herman (1986) 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 (1986): 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 (Richardson et. al, 1985; Malme *et al*. 1983). 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). Weinrich *et al*. (1992) associated "moderate" and "strong" behavioral responses with alarm reactions and stress responses, respectively.

Jahoda *et al*. (2003) 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.

Beale and Monaghan (2004) 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.

As we discussed in the *Status of the Species* section of these Opinions, 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 1993, Lande *et al*. 2003, Melbourne and Hastings 2008). At these population sizes, 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. We do not yet know to what degree the U.S. and Canadian Traffic Separation Schemes, speed restrictions, and vessel routing activities that NOAA has established along the Atlantic Coast of the United States would reduce the number of North Atlantic right whales that are killed or injured during collisions with ships.

The same statement does not appear to be true for blue, fin, humpback, sei, or sperm whales in the action areas for this consultation, which 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*. 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*[12], we infer from their increasing abundance that the *Environmental Baseline* is not currently preventing their population size from increasing.

Impact on Endangered and Threatened Sea Turtles. Several of the categories of activities described in this *Environmental Baseline* have had significant and adverse consequences for nesting aggregations of sea turtles whose individuals occur in the Action Area. In particular, the commercial fisheries that have been described have captured substantial numbers of green, hawksbill, leatherback, and loggerhead sea turtles each year.

Although only small percentages of these sea turtles are estimated to have died as a result of their capture, the actual number of sea turtles that are estimated to have died in these fisheries each year for the past 5 to 10 years (or longer) still amounts to about 6,000 sea turtles each year. 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.

These fisheries are expected to continue into the foreseeable future at levels of effort that are roughly equivalent to current levels. As a result, we expect the number of sea turtles that are captured and killed in these fisheries to continue for the foreseeable future. These estimates mean that, every five years, more than 800,000 loggerhead sea turtles would be captured in these fisheries, with more than 23,000 of them dying as a result of that capture; about 19,000 leatherback sea turtles would be captured, with about 1,500 of them dying; about 95,000 green sea turtles would be captured, with about 2,900 of them dying; and about 3,200 hawksbill sea turtles being captured and killed.

Given that we are certain that nest counts of species like northwest Atlantic loggerhead sea turtles have been declining and are currently declining, these additional mortalities seem likely to increase the rate at which nesting aggregations of this species are declining. Even if these mortalities did not increase the rate at which these nesting aggregations are declining, merely continuing the rate at which they are currently declining would be sufficient to increase the probability of nest counts in these nesting aggregations to decline to zero. Because we know that populations of sea turtles cannot increase over time if the number of nest counts decline, the mortalities associated with these fisheries are likely to increase the probability of these populations of sea turtles becoming extinct in the wild.

[12] Increases in a population's abundance is only one piece of evidence that a population is improving in status; however, because populations can increase while experiencing low juvenile survival (for example, if low juvenile survival is coupled with reduced adult mortality) or when those individuals that are most sensitive to a stress regime die, leaving the most resistant individuals, increases in abundance are not necessarily indicative of the long-term viability of a species.

5.0 Effects of the Proposed Action

In *Effects of the Action* sections of these Opinions, NMFS presents the results of its 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 an 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 proposed action poses to endangered and threatened species.

Before we present our effects analyses, we need to address a few definitions. The ESA does not define harassment nor has NMFS defined the term pursuant to the ESA through regulation. However, the Marine Mammal Protection Act of 1972, as amended, defines harassment as any act of pursuit, torment, or annoyance which has the potential to injure a marine mammal or marine mammal stock in the wild or 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 [16 U.S.C. 1362(18)(A)]. For military readiness activities, this definition of "harassment" has been amended to mean "any act that disturbs or is likely to disturb a marine mammal or marine mammal stock in the wild by causing disruption of natural behavioral patterns, including, but not limited to, migration, surfacing, nursing, breeding, feeding, or sheltering, to a point where such behaviors are abandoned or significantly altered." (Public Law 108-136, 2004). The latter portion of this definition (that is, "...causing disruption of behavioral patterns including...migration, breathing, nursing, breeding, feeding, or sheltering") is almost identical to the U.S. Fish and Wildlife Service's regulatory definition of "harass"[13] pursuant to the ESA:

For these Opinions, we define harassment similarly: an intentional or unintentional human act or omission that creates the probability of injury to an individual animal by disrupting one or more behavioral patterns that are essential to the animal's life history or its contribution to its populations of those species.

5.1 Potential Stressors

---

[13] An intentional or negligent act or omission which creates the likelihood of injury to wildlife by annoying it to such an extent as to significantly disrupt normal behavior patterns which include, but are not limited to, breeding, feeding, or sheltering (50 CFR 17.3).

As discussed in the *Approach to the Assessment* section of these Opinions, the U.S. Navy's proposed training activities along the Atlantic Coast of the United States are likely to produce the following potential stressors:

Table 12. Potential stressors associated with the training the U.S. Navy proposes to conduct in the Northeast Operating Area and Virginia Capes, Cherry Point, and Jacksonville Range Complexes

Potential Stressor		Training Area			
		Northeast	Virginia Capes	Cherry Point	Jacksonville
1	Collisions risks associated with Navy vessels	Y	Y	Y	Y
2	Disturbance associated with Navy surface vessels and aircraft	Y	Y	Y	Y
3	Shock waves (pressure waves) from underwater detonations	N	Y	Y	Y
4	Sound waves produced by the underwater detonations	N	Y	Y	Y
5	Chemicals in the explosives that are introduced into the water during detonations	N	Y	Y	Y
6	Expended ordnance and debris fields	N	Y	Y	Y
Stressors Associated with Interrelated Activities (Atlantic Fleet Active Sonar Training)					
7	Mid-frequency active sonar	Y	Y	Y	Y
8	High-frequency active sonar	Y	Y	Y	Y
9	Explosive source associated with IEER system	Y	Y	Y	Y
10	Parachutes associated with sonobuoys	Y	Y	Y	Y

We discuss each of these potential stressors in greater detail in the descriptions that follow. We follow those descriptions with a presentation of our exposure analyses, followed by the results of our response analyses. As outlined in the introductory paragraph of this section, we conclude our effects analyses with an Integration and Synthesis which contains the results of our risk analyses.

Although activities the U.S. Navy plans to conduct on the Undersea Warfare Training Range is interrelated to the training activities the U.S. Navy conducts on its East Coast Range Complexes, the Undersea Warfare Training Range is not scheduled to become operational until 2014-2015. Therefore, during the one-year duration of the proposd Letters of Authorization that are the focus of this consultation, the U.S. Navy would not conduct training activities on the training range. However, some activities associated with the installation of the training range might begin over the next 12 months. Our 2009 Opinion on the Undersea Warfare Training Range concluded that endangered blue, fin, humpback, North Atlantic right, sei, and sperm whales and green, hawksbill, Kemp's ridley, leatherback, and loggerhead sea turtles are not likely to be exposed to activities that occur during the Installation Phase of the proposed Undersea Warfare Training Range, which is interrelated with the activities considered in these Opinions. These species are not likely to respond to exposures that are not likely to occur; therefore, these species are not likely to be adversely affected by the installation phase of the U.S. Navy's proposed Undersea Training Range. We do not expect other direct or indirect effects of this interrelated activity to occur between June 2011 and June 2012.

5.1.1 Collision Risks Associated with Navy Vessel Traffic

As discussed in the *Status of the Species* narratives and the *Environmental Baseline* baseline section of these Opinions, ship strikes pose significant threats to populations of endangered whales along the Atlantic coast, particularly North Atlantic right whales. As discussed in the *Description of the Proposed Action* section of these Opinions, many of the training activities the U.S. Navy proposes to conduct in the Northeast Operating Areas, Virginia Capes Range Complex, Cherry Point Range Complex, and Jacksonville Range Complex are interrelated with active sonar training activities the U.S. Navy proposed to conduct along the Atlantic Coast of the United States. For example, mine countermeasures training, composite training unit exercises, and joint task force exercises involve combinations of ordnance discussed as part of the *Description of the Proposed Action* as well as active sonar systems discussed in our 2009 and subsequent Opinions on the Atlantic Fleet Active Sonar Training, which are interrelated with the proposed actions that are the primary focus of these Opinions. In fact, some of the vessels involved in these activities engage in both mine countermeasures training and employ active sonar as part of the same training activity. As a result, we consider the potential stressors represented by vessel traffic associated with the proposed training exercises and vessel traffic that was associated with active sonar training activities.

Vessel traffic actually represents a suite of stressors or stress regimes that pose several potential hazards to endangered and threatened species in the Northeast Operating Area, Virginia Capes Range Complex, Cherry Point Range Complex, and Jacksonville Range Complex. First, the size and speed of these surface vessels pose some probability of collisions with marine mammals and sea turtles. Second, surface vessel traffic and aircraft potentially represent an acute or chronic source of disturbance to marine animals in the Northeast Operating Areas and the three range complexes. We discuss the potential risks of collisions as stressors in this sub-section and potential disturbance associated with Navy vessel traffic in the next sub-section.

The U.S. Navy estimated that the proposed training activites would result in about 1,420 steaming days per year in the Virginia Capes Range Complex, 950 steaming days in the Cherry Point Range Complex, and 1,050 steaming days in the Jacksonville Range Complex[14]. Vessel movements unrelated to training activities — for example, for storm evasion, deployment transits, and movements in basins to rearrange ships for repairs, berthing, loading, and off-loading from designated piers — would increase these estimates. With the Transit Protection System the U.S. Navy proposes to employ at Kings Bay, Georgia, the U.S. Navy would employ up to 16 escort security boats that would engage in between 130 to 170 events per year or 10 to 15 times per month.

The size of the ships involved in the proposed training activities would range from 362 feet (a nuclear submarine) to 1,092 feet (for a nuclear-powered aircraft carrier). A variety of smaller craft such as service

[14] 11 The U.S. Navy calculated steaming days by summing the number of steaming hours proposed in each range complex, dividing by 24 hours per day, and rounding to the nearest 10 days.

vessels engaged in routine operations or employed as opposition forces during training events would also be operating within the different range complexes. During training activities, ship speeds generally range from 10 to 14 knots; however, these vessels would also operate within the entire spectrum at higher speeds during specific events, such as pursuing and overtaking hostile vessels, evasive maneuvers, and maintenance or performance checks (such as ship trials). The size and speeds of smaller vessels would vary. For example, the rigid hull inflatable boat Warfare RHIB is 35 feet in length and has a speed greater than 40 knots.

5.1.2 Disturbance Associated with Surface Vessel Traffic and Aircraft

As discussed in the preceding subsection, the U.S. Navy estimated that the proposed training activites would result in about 1,420 steaming days per year in the Virginia Capes Range Complex, 950 steaming days in the Cherry Point Range Complex, and 1,050 steaming days in the Jacksonville Range Complex. Vessel movements unrelated to training activities — for example, for storm evasion, deployment transits, and movements in basins to rearrange ships for repairs, berthing, loading, and off-loading from designated piers — would increase these estimates. With the Transit Protection System the U.S. Navy proposes to employ at Kings Bay, Georgia, the U.S. Navy would employ up to 16 escort security boats that would engage in between 130 to 170 events per year or 10 to 15 times per month.

The size of the ships involved in the proposed training activities would range from 362 feet (a nuclear submarine) to 1,092 feet (for a nuclear-powered aircraft carrier). A variety of smaller craft such as service vessels engaged in routine operations or employed as opposition forces during training events would also operating within the different range complexes. During training activities, ship speeds generally range from 10 to 14 knots; however, these vessels would also operate within the entire spectrum at higher speeds during specific events, such as pursuing and overtaking hostile vessels, evasive maneuvers, and maintenance or performance checks (such as ship trials). The size and speeds of smaller vessels would vary. For example, rigid hull inflatable boat Warfare RHIB is 35 feet in length and has a speed greater than 40 knots.

Because of the number of vessels involved in U.S. Navy training exercises, their speed, their use of course changes as a tactical measure, and sounds associated with their engines and displacement of water along their bowline, 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 used during Navy training activities, the available evidence suggests that major training exercises (for example, COMPTUEX, JTFEX, IAC, and SEASWITI), unit and intermediate-level exercises, and RDT&E activities would represent different stress regimes because of differences in the number of vessels involved, vessel maneuvers, and vessel speeds.

Studies of interactions between surface vessels and marine mammals have demonstrated that surface vessels also represent a source of acute and chronic disturbance for marine mammals (Au and Green

1990, Au and Perryman 1982, Bain *et al.* 2006, Bauer 1986, Bejder 1999, 2006a, 2006b; Bryant *et al.* 1984, Corkeron 1995, Erbé 2000, Félix 2001, Goodwin and Cotton 2004, Hewitt 1985, Lemon *et al.* 2006, Lusseau 2003, 2006; Lusseau and Bejder 2007, Magalhães *et al.* 2002, Ng and Leung 2003, Nowacek *et al.* 2001, Richter *et al.* 2003, 2006; Scheidat *et al.* 2004, Simmonds 2005, Watkins 1986, Williams and Ashe 2007, Williams *et al.* 2002, 2006a, 2006b; Würsig *et al.* 1998). Specifically, in some circumstances, marine mammals respond to vessels with the same behavioral repertoire and tactics they employ when they encounter predators, although it is not clear what environmental cue or cues marine animals might respond to: the sounds of waters being displaced by the ships, the sounds of the ships' engines, or a combination of environmental cues surface vessels produce while they transit.

These studies establish that free-ranging cetaceans 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 (Goodwin and Green 2004; Lusseau 2006). Several, authors, however, suggest that the noise generated by the vessels is probably an important contributing factor to the responses of cetaceans to the vessels (Blane and Jackson 1994 *et al.* 1992, 1994), so we may not be able to treat the effects of vessel traffic as independent of engine and other sounds associated with the vessels.

Sea turtles would be expected to detect approaching vessels via auditory and/or visual cues based on knowledge of their sensory biology (Bartol and Ketten 2006, Bartol and Musick 2003, Ketten and Bartol 2006, Lewenson et al. 2004). Little information is available on how turtles respond to vessel approaches. Hazel *et al* (2007) reported sea turtle reaction time was greatly dependent on the speed of the vessel; sea turtles were able to react faster to slower moving vessels than to faster moving vessels. Also, sea turtle reactions to vessels elicited short-term responses. Sea turtle hearing sensitivity is not well studied. Several studies using green, loggerhead, and Kemp's ridley turtles suggest that sea turtles are most sensitive to low-frequency sounds, although this sensitivity varies slightly by species and age class (Bartol *et al*. 1999, Ketten and Bartol 2006, Lenhardt 1994, Ridgway *et al*. 1969).

Disturbance Associated with Aircraft. Several of the activities the U.S. Navy proposes to conduct in the Virginia Capes, Cherry Point, and Jacksonville Range Complexes also 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.

Although several studies have demonstrated the potential adverse effects of aircraft on pinnipeds on haul-out sites or rookeries, Richardson *et al*. (1995) 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. However, several authors have reported that sperm whales do not react to fixed-wing aircraft or helicopters in some circumstances (Clarke 1956, Gambell 1968, Green *et al.* 1992) and react in others (Clarke 1956, Fritts *et al.* 1983, Mullin *et al.* 1991, Patenaude *et al.* 2006, Richter *et al.* 2003, 2006, Smultea *et al.* 2008, Würsig *et al.* 1998).

Based on sea turtle sensory biology (Ridgway *et al*. 1969, Lenhardt *et al*. 1994, Bartol 1999, Bartol and Musick 2003, Ketten and Bartol 2006), 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.

Although we recognize sounds produced by aircraft as a potential stressor, we do not have sufficient information to estimate the probability of marine animals or sea turtles being exposed to aircraft noise associated with the training exercises and other activities the U.S. Navy plans to conduct in the Virginia Capes, Cherry Point and Jacksonville Range Complexes.

5.1.3 Shock Waves and Sound Waves Produced by Underwater Detonations

The U.S. Navy plans to continue to employ several kinds of explosive ordnance on the Virginia Capes, Cherry Point, and Jacksonville Range Complexes. In the Northeast Operating Areas, the U.S. Navy only proposes training activities that include man overboard drills, towed array operations (passive), small arms training, and surface gunnery (inert only), so those training activities would not result in underwater detonations.

Explosives detonated underwater introduce loud, impulsive, broadband sounds into the marine environment. At its source, the acoustic energy of an explosive is, generally, much greater than that of a sonar, so careful treatment of them is important, since they have the potential to injure. Three source parameters influence the effect of an explosive: the net effective weight of the explosive, the type of explosive material, and the detonation depth. The net explosive weight accounts for the first two parameters. The net explosive weight of an explosive is the weight of only the explosive material in a given round, referenced to the explosive power of TNT.

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). Since most of the explosives the Navy uses in the Northeast Operating Areas and the Virginia Capes, Cherry Point, and Jacksonville Range Complexes are munitions that detonate essentially upon impact, the effective source depths are very shallow so the surface-image interference effect can be pronounced. In order to limit the cancellation effect (and thereby provide exposure estimates that tend toward the worst case), relatively deep detonation depths are used. To remain consistent with previous models the Navy has used, the Navy used source depths of one foot for gunnery rounds. For missiles and bombs, the Navy used source depths of 2 meters. For MK-48 torpedoes, which detonate immediately below a target's hull, the Navy used nominal depths of 50 feet for their analyses.

The number of endangered or threatened species that might be exposed to explosions associated with this ordnance treat each in-water explosion as an independent event. The cumulative effect of a series of explosives can often be estimated by addition if the detonations are spaced widely in time and space which would provide marine animal's sufficient time to move out of an area affected by an explosion. As a result, the populations of animals that are exposed to in-water explosions are assumed to consist of different animals each time.

5.1.4 Expended Ordnance

Many of the activities the U.S. Navy plans to conduct on the Virginia Capes, Cherry Point, and Jacksonville Range Complex introduce expended ordnance and other fragments into the marine environment. In the Northeast Operating Areas, expended materials would consist of small arms munitions and inert surface gunnery. In the Northeast Operating Areas, the U.S. Navy only proposes training activities that include man overboard drills, towed array operations (passive), small arms training, and surface gunnery (inert only), so the only expended ordnance in those Operating Areas would be from small arms training.

BOMBS. The majority of the bombs, the U.S. Navy would employ during training activities it conducts on the Northeast Operating Areas and the Virginia Capes, Cherry Point, and Jacksonville Range Complexes would be practice bombs that are not equipped with explosive warheads. For example, 61 percent of the bombs the U.S. Navy has employed on the Virginia Capes Range Complex were practice bombs without explosive warheads while 39 percent of the bombs dropped during exercises on the range complex contained high explosives; 99 percent of those bombs would explode within 5 feet of the ocean surface (U.S. Navy 2005b) leaving only fragments.

Practice bombs entering the water would consist of materials like concrete, steel, and iron, and would not contain the combustion chemicals found in the warheads of explosive bombs. These components are consistent with the primary building blocks of artificial reef structures. The steel and iron, although durable, would corrode over time, with no noticeable environmental impacts. The concrete is also durable and would offer a beneficial substrate for benthic organisms. After sinking to the bottom, the physical structure of bombs would be incorporated into the marine environment by natural encrustation and/or sedimentation (U.S. Navy 2006b).

MISSILES. Missiles would be fired by aircraft, ships, and Naval Special Warfare operatives at a variety of airborne and surface targets on the Virginia Capes, Cherry Point, and Jacksonville Range Complexes. In general, the single largest hazardous constituent of missiles is solid propellant, which is primarily composed of rubber (polybutadiene) mixed with ammonium perchlorate (for example, solid double-base propellant, aluminum and ammonia propellant grain, and arcite propellant grain). Hazardous constituents are also used in igniters, explosive bolts, batteries (potassium hydroxide and lithium chloride), and warheads (for example, PBX-N highexplosive components; PBXN-106 explosive; and PBX (AF)-108 explosive). Chromium or cadmium may also be found in anti-corrosion compounds coating exterior missile surfaces. In the event of an ignition failure or other launch mishap, the rocket motor or portions of the unburned propellant may cause environmental effects. Experience with Hellfire missiles has shown that if the rocket motor generates sufficient thrust to overcome the launcher hold-back, all of the rocket propellant is consumed. In the rare cases where the rocket does not generate sufficient thrust to overcome the holdback (hang fire or miss fire), some propellant may remain unburned but the missile remains on the launcher. Jettisoning the launcher is a possibility for hang fire or misfire situations, but in most cases the aircraft returns to base where the malfunctioning missile is handled by explosive ordnance disposal personnel.

Non-explosive practice missiles generally do not explode upon contact with the target or sea surface. The main environmental effect would be the physical structure of the missile entering the water. Practice missiles do not use rocket motors and, therefore, do not have potentially hazardous rocket fuel. Exploding warheads may be used in airto-air missile exercises, but those missiles would explode at an offset to the target in the air, disintegrate, and fall into the ocean to avoid damaging the aerial target. High explosive missiles used in air-to-surface exercises explode near the water surface (U.S. Navy 2006a). For example, missiles employed during a HARMEX would detonate 30 - 60 feet (9.1 – 18.3 m) above the ocean surface.

The principal potential stressor from missiles would be unburned solid propellant residue. Solid propellant fragments would sink to the ocean floor and undergo changes in the presence of seawater. The concentration would decrease over time as the leaching rate decreased and further dilution occurred. The aluminum would remain in the propellant binder and eventually would be oxidized by seawater to aluminum oxide. The remaining binder material and aluminum oxide would pose no threat to the marine environment (DoN, 1996).

TARGETS. At-sea targets are usually remotely operated airborne, surface, or subsurface traveling units, most of which are designed to be recovered for reuse. Aerial and surface targets would be deployed annually in the Virginia Capes, Cherry Point, and Jacksonville Range Complexes. Small concentrations of fuel and ionic metals would be released during battery operation.

A typical aerial target drone is powered by a jet fuel engine, generates radio frequency (RF) signals for tracking purposes, and is equipped with a parachute to allow recovery. Drones also contain oils, hydraulic fluid, batteries, and explosive cartridges as part of their operating systems. There are also recoverable, remotely controlled target boats and underwater targets designed to simulate submarines. If severely damaged or displaced, targets may sink before they can be retrieved. Aerial targets employed on the Virginia Capes, Cherry Point, and Jacksonville Range Complexes would include AST/ALQ/ESM pods, Banner drones, BQM-74E drones, Cheyenne, Lear Jets, and Tactical Air-Launched Decoys, which are the only expended targets (these targets are non-powered, air-launched, aerodynamic vehicle).

Surface targets would include Integrated Maritime Portable Acoustic Scoring and Simulator Systems, Improved Surface Tow Targets, QST-35 Seaborne Powered Targets, and expendable marine markers (smoke floats). Expended surface targets commonly used in addition to marine markers include cardboard boxes, 55-gallon steel drums, and a 10-foot-diameter red balloon tethered by a sea anchor (also known as a “killer tomato”). Floating debris, such as Styrofoam, may be lost from target boats.

Most target fragments would sink quickly in the sea. Expended material that sinks to the sea floor would gradually degrade, be overgrown by marine life, and/or be incorporated into the sediments. Floating non-hazardous expended material may be lost from target boats and would either degrade over time or wash ashore as flotsam. Non-hazardous expended materials are defined as the parts of a device made of non-reactive material. Typical non-reactive material includes metals such as steel and aluminum; polymers, including nylon, rubber, vinyl, and plastics; glass; fiber; and concrete. While these items represent persistent seabed litter, their strong resistance to degradation and their chemical composition mean they do not chemically contaminate the surrounding environment by leaching heavy metals or organic compounds.

GUN AMMUNITION. Naval gun fire within the Virginia Capes, Cherry Point, and Jacksonville Range Complexes would use non-explosive and explosive 5-inch and 76-millimeter (mm) rounds, and non-explosive, practice, 2.75-inch rockets. More than 80 percent of the 5-inch and 76-mm rounds training rounds and all of the rockets would be non-explosive and contain an iron shell and sand, iron grit, or cement filler. Rapid-detonating explosive would be used in explosive rounds. Unexploded shells and non-explosive practice munitions would not be recovered and would sink to the ocean floor. Solid metal components (mainly iron) of unexploded ordnance and non-explosive practice munitions would also sink.

High-explosive, 5-inch shells are typically fuzed to detonate within 3 feet of the water surface. Shell fragments rapidly decelerate through contact with the surrounding water and settle to the sea floor. Unrecovered ordnance would also sink to the ocean floor. Iron shells and fragments would be corroded by seawater at slow rates, with comparably slow release rates. Over time, natural encrustation of exposed surfaces would occur, reducing the rate at which corrosion occurred. Rates of deterioration would vary, depending on the material and conditions in the immediate marine and benthic environment. However, the release of contaminants from unexploded ordnance, nonexplosive practice munitions, and fragments would not result in measurable degradation of marine water quality.

The rapid-detonating explosive material of unexploded ordnance would not typically be exposed to the marine environment. Should the rapid-detonating explosive be exposed on the ocean floor, it would break down within a few hours (U.S. Navy 2001). Over time, the rapid-detonating explosive residue would be covered by ocean sediments or diluted by ocean water.

In the past, about 96 anti-swimmer grenade training events have been performed on the Jacksonville Range Complex per year. Eighty explosive grenades would be used per year (not all events would employ explosive grenades during these exercises). Mine Neutralization events involve Explosive Ordnance Disposal (EOD) detachments placing explosive charges next to or on non-explosive practice mines. Charges used by EOD divers consist of 20-lbs explosives, which reflects the size of charges EOD divers use to detonate mines in combat or real-world conditions. In the past, about 18 20-lbs charges would be used per year. Over the next 12 months there will be about 10 of these events in the Jacksonville Range Complex, however, the U.S. Navy expectes to increase the number of these events from 20 to 319 in the Virginia Capes Range Complex. The combustion products from the detonation of high explosives are commonly found in sea water— carbon monoxide, carbon dioxide, hydrogen, water, nitrogen, and ammonia. The primary contaminants released from explosives used in mine warfare training are nitroaromatic compounds such as trinitrotoluene, rapid-detonating explosive, and octogen (High Melting Explosive; URS *et al*. 2000).

CHAFF. Radio frequency chaff (chaff) is an electronic countermeasure designed to reflect radar waves and obscure aircraft, ships, and other equipment from radar-tracking sources. Chaff is non-hazardous and consists of aluminum-coated glass fibers (about 60% silica and 40% aluminum by weight) ranging in lengths from 0.3 to 3 inches with a diameter of about 40 micrometers. Chaff is released or dispensed from military vehicles in cartridges or projectiles that contain millions of chaff fibers. When deployed, a diffuse cloud of fibers undetectable to the human eye is formed. Chaff is a very light material that can remain suspended in air anywhere from 10 minutes to 10 hours. It can travel considerable distances from its release point, depending on prevailing atmospheric conditions (Arfsten *et al*. 2002).

For each chaff cartridge used, a plastic end-cap and Plexiglas piston is released into the environment in addition to the chaff fibers. The end-cap and piston are both round and are 1.3 inches in diameter and 0.13 inches thick (Spargo, 2007). Chaff would be used during chaff exercises throughout the Virginia Capes, Cherry Point, and Jacksonville Range Complexes. The fine, neutrally buoyant chaff streamers act like particulates in the water, temporarily increasing the turbidity of the ocean's surface. However, they are quickly dispersed and turbidity readings return to normal. The end-caps and pistons would sink; however, some may remain at or near the surface if it were to fall directly on a dense *Sargassum* mat. The expended material could also be transported long distances before becoming incorporated into the bottom sediments.

Based on the dispersion characteristics of chaff, large areas of open water within the Virginia Capes, Cherry Point, and Jacksonville Range Complexes would be exposed to chaff, but the chaff concentrations would be low. For example, Hullar *et al.* (1999) calculated that a 4.97-mile by 7.46-mile area (37.1 square miles or 28 square nautical miles) would be affected by deployment of a single cartridge containing 150 grams of chaff. The resulting chaff concentration would be about 5.4 grams per square nautical mile. This corresponds to fewer than 179,000 fibers per square nautical mile or fewer than 0.005 fibers per square foot, assuming that each canister contains five million fibers.

5.1.5 Chemicals in Explosive Charges and Ordnance

The chemical products of deep underwater explosions are initially confined to a thin, circular area called a "surface Pool". Young (1995) estimated that 100% of the solid explosion products and 10% of the gases remain in the pool, which is fed by upwelling currents of water entrained by the rising bubble produced by a detonation (see Table 13). After the turbulence of an explosion has dispersed, the surface pool would stabilize and chemical products would become uniformly distributed within the pool. A surface pool is usually not visible after about five minutes. As a surface pool continues to expand, chemical products would be further diluted and become undetectable. Because of continued dispersion and mixing, there would be no buildup of explosion products in the water column.

Table 13. Predicted concentrations of explosion products in seawater, compared with permissible concentrations (from U.S. Navy 2007)

Explosion Product	Predicted Concentration (mg/L)	Permissible Concentration (mg/L)
Carbon dioxide (CO2)	0.00262	1.0
Carbon monoxide (CO)	0.0293	0.552
Ammonia (NH3)	0.00230	0.092b
Ethane (C2H6)	0.00469	120
Propane (C3H8)	0.00135	120
Hydrogen cyanide (HCN)	0.000298	0.001 - 0.036
Methane (CH4)	0.000126	120
Methyl alcohol (CH3OH)	0.0000107	3.60
Formaldehyde (CH2O)	0.00000534	0.0414
Carbon (C)	0.143	NA
Acetylene (C2H2)	0.00000668	73
Phosphine (PH3)	0.00000935	0.0055
Aluminum oxide (Al2O3)	0.434	NA

The concentrations of chemicals associated with the explosive materials are not hazardous to marine mammals, sea turtles, their prey, competitors, or predators. Those chemicals are not likely to adversely affect these species.

5.1.6 Active Sonar

As discussed in the *Description of the Proposed Action* section of these Opinions, many of the training activities the U.S. Navy proposes to conduct in the Northeast Operating Areas, Virginia Capes Range Complex, Cherry Point Range Complex, and Jacksonville Range Complex are interrelated with active sonar training activities the U.S. Navy proposed to conduct along the Atlantic Coast of the United States. Any of these training activities could employ any of the bombing exercises, gunnery exercises, mine warfare activities, missile exercises, or other activities discussed in the *Description of the Proposed Action* as well as active sonar systems discussed in our 2009 and subsequent Opinions on theAtlantic Fleet Active Sonar Training (which is why we treat them as interrelated activities).

During mine countermeasures training the U.S. Navy proposes to conduct in the Virginia Capes, Cherry Point, and Jacksonville Range Complexes, the U.S. Navy employs several ship or submarine-mounted mid-frequency active sonar systems: AN/SQS-53, AN/SQS-56, AN/BQQ-5 or 10. Helicopters engaged in airborne MCM training use equipment that includes: AN/AQS-20 Mine Hunting System (employing side-looking sonar); AN/AES-1 Airborne Laser Mine Detection System; and AN/ALQ-220 Organic Airborne Surface Influence Sweep.

COMPOSITE TRAINING UNIT EXERCISES (or COMPTUEX) are Integration Phase, at-sea, major range events. When they involve carrier strike groups, these exercises integrate an aircraft carrier and carrier air wing with surface and submarine units. When they involve expeditionary strike groups, these exercises integrate amphibious ships with their associated air wing, surface ships, submarines, and Marine Expeditionary Unit. Along the Atlantic Coast. As proposed, these exercises would occur within and seaward of the Virginia Capes, Cherry Point, and Jacksonville-Charleston Operating Areas. However, based on eight after-action-reports the U.S. Navy submitted on major training exercises it conducted from the summer of 2006 through the summer of 2008, all but two occurred primarily within the Cherry Point and Charleston Operating Areas, with smaller portions occurring in the Jacksonville Operating Areas. Only one of these major training exercises occurred within the Virginia Capes Operating Area. If this pattern is representative of what we might expect in the future, we would expect most of the major training exercises to occur in the Cherry Point Operating Area with portions occurring in the Charleston-Jacksonville Operating Areas.

Live-fire activities that may take place during a COMPTUEX include long-range air strikes, Naval Surface Fire Support (which are discussed in greater detail in narratives that follow), and surface-to-air, surface-to-surface, and air-to-surface missile exercises. A Marine Expeditionary Unit also conducts realistic training based on anticipated operational requirements and to further develop the required coordination between Navy and Marine Corps forces. Special Operations training may also be integrated with the exercise scenario. These exercises typically last for 21 days and may include two 1-day, scenario-driven, “mini” battle problems, culminating with a scenario-driven 3-day final battle problem.

Sonars employed in these exercises include AN/SQS-53, AN/SQS-56, AN/AQS-13 or AN/AQS-22 dipping sonar, and the AN/BQQ-10 sonar. Up to 218 tonal sonobuoys, 28 explosive source sonobuoys (AN/SSQ-110A), 5 receiver sonobuoys (AN/SSQ-101), and four acoustic device countermeasures (MK-1, MK-2, MK-3, MK-4, noise acoustic emitter, and the AN/SLQ-25A NIXIE) are typically used per exercise. The number of passive sonobuoys deployed during these exercises can vary.

JOINT TASK FORCE EXERCISES are also major range events that are the culminating exercises in Integrated Phase training for Carrier and Expeditionary Strike Groups. For Expeditionary Strike Groups, Joint Task Force Exercises incorporate Amphibious Ready Group Certification Exercises for amphibious ships and Special Operations Capable Certification for Marine Expeditionary Units. Activities conducted during these exercises include littoral antisubmarine warfare activities, coordinated anti-submarine warfare activities, Improved Extended Echo Ranging (IEER) Systems training, and freeplay exercises. They typically include other Defense Department services or Allied forces.

When schedules allow, these exercises may be conducted concurrently for a Carrier Strike Group and an Expeditionary Strike Group. These exercises normally last for 10 days (not including a 3-day force protection exercise that occurs in-port) and occur two times per year in shallow and deep water portions located within and seaward of the Virginia Capes, Cherry Point, and Jacksonville-Charleston Operating Areas.

Carrier Strike Group COMPTUEX and Joint Task Force Exercises often take place concurrently to produce exercises that are called Combined Carrier Strike Group COMPTUEX/JTFEX. Typically, four guided missile destroyers, two fast frigates, and three submarines participate in a Joint Task Force Exercises. Sonars employed in this scenario include the AN/SQS-53, AN/SQS-56, AN/AQS-13 or AN/AQS-22 dipping sonar, and the AN/BQQ-10 sonars. Up to 174 tonal sonobuoys (e.g., AN/SSQ-62), 28 explosive source sonobuoys (AN/SSQ-110A), five receiver sonobuoys (AN/SSQ-101), and 2 four acoustic device countermeasures (MK-1, MK-2, MK-3, MK-4, noise acoustic emitter, and the AN/SLQ-25A NIXIE) are typically used per exercise. The number of passive sonobuoys that are deployed during these exercises can vary.

High-frequency active sonar

Several of the torpedoes and the AN/BQS-15 sonar system, which Navy submarines use for under-ice navigation and mine-hunting, produce high-frequency sounds (see Table 4). In addition, two of the active sonar systems the U.S. Navy employs as part of its mine warfare scenarios – AN/AQS-14, which is an active-controlled, helicopter-towed mine-hunting active sonar and AN/AQS-24 which is an upgraded version of AN/AQS-14 – operate at frequencies higher than 200 kHz.

Mid-frequency active sonar

Naval sonars operate on the same basic principle as fish-finders (which are also a kind of sonar): brief pulses of sound, or "pings" are projected into the ocean and an accompanying hydrophone system in the sonar device listens for echoes from targets such as ships, mines or submarines. Several sonar systems are likely to be employed during the active sonar training activities the U.S. Navy plans to conduct in the Northeast Operating Areas and the Virginia Capes, Cherry Point, and Jacksonville Range Complexes, but several systems pose potential risks to listed resources (we should note that other navies that might be involved in some of the active sonar training exercises, such as Joint Task Force Exercises, employ similar active sonar systems as well, but we do not have the information necessary to describe those systems).

As discussed in the *Description of the Proposed Action* section of these Opinions, a variety of surface ships participate in Navy training exercises, including guided missile cruisers, destroyers, guided missile destroyers, and frigates. Some ships (e.g., aircraft carriers) do not have any onboard active sonar systems, other than fathometers. Others, like guided missile cruisers, are equipped with active as well as passive sonars for submarine detection and tracking. The primary surface ship sonars considered are:

1. The AN/SQS-53 which is a large, active-passive, bow-mounted sonar that has been operational since 1975. AN/SQS-53 is the U.S. Navy‘s most powerful surface ship sonar and is installed on Ticonderoga (22 units) and Arleigh Burke I/II/IIIa (51 units) class vessels in the U.S. Navy (Polmar 2001, D`Spain *et al.* 2006). This sonar transmits at a center frequency of 3.5 kHz at sources levels of 235 dBRMS re: 1 Pa at 1 meter. The sonar has pulse durations between 1 and 2 seconds, with about 24-second intervals between pulses. AN/SQS-53 operates at depths of about 7 meters.

The AN/SQS-53 is a computer-controlled, hull-mounted surface-ship sonar that has both active and passive operating capabilities, providing precise information for anti-submarine warfare weapons control and guidance. The system is designed to perform direct-path anti-submarine warfare search, detection, localization, and tracking from a hull-mounted transducer array. The AN/SQS-53 sonar is installed on Arleigh Burke Class guided missile destroyers and Ticonderoga Class guided missile cruisers.

The AN/SQS-53 Kingfisher is a modification that provides a surface ship with the ability to detect mine-like objects. However, Navy vessels would use this sonar only when entering and leaving a port. As a result, we would not expect endangered marine mammals to be exposed to this sonar system, although sea turtles that occur in the ports are likely to be exposed to active sonar from this system.

The AN/SQS-56 system is a lighter active-passive bow-mounted sonar that has been operational since 1977. AN/SQS-56 is installed on FFG-7 (33 units) class guided missile frigates in the U.S. Navy (Polmar 2001, D`Spain *et al.* 2006). This sonar transmits at a center frequency of 7.5 kHz and a source level of 225 dBRMS re: 1 Pa at 1 meter source level. This sonar also has pulse durations between 1 and 2 seconds, with about 24-second intervals between pulses. AN/SQS-56 operates at depths of about 6 meters.

Sonar Systems Associated with Submarines

As discussed in the *Description of the Proposed Action*, tactical military submarines (i.e. 29 attack submarines as of 2008) equipped with hull-mounted mid-frequency use active sonar to detect and target enemy submarines and surface ships. The predominant active sonar system mounted on submarines is AN/BQQ-10 sonar that is used to detect and target enemy submarines and surface ships. Two other systems — AN/BQQ-5 and AN/BSY-1/2 — have operational parameters that would affect marine mammals in ways that are similar to the AN/BQQ-10.

1. AN/BQQ-10 (also known as Advanced Rapid Commercial-Off-the-Shelf Insertion– a four-phase program for transforming existing submarine sonar systems (i.e., AN/BQQ -5) from legacy systems to more capable and flexible active and passive systems with enhanced processing using commercial-off-the-shelf components. The system is characterized as mid-frequency active sonar, although the exact frequency range is classified. The AN/BQQ-10 is installed on Seawolf Class SSNs, Virginia Class SSNs, Los Angeles Class SSNs, and Ohio Class SSBN/nuclear guided missile submarines (SSGNs). The BQQ-10 systems installed on Ohio Class SSBNs do not have an active sonar capability.

2. AN/BQQ-5 – a bow- and hull-mounted passive and active search and attack sonar system. The system includes the TB-16 and TB-23 or TB-29 towed arrays and Combat Control System MK 2. This sonar system is characterized as MFA, although the exact frequency range is classified. The AN/BQQ-5 sonar system is installed on Los Angeles Class nuclear attack submarines (SSNs) and Ohio Class ballistic missile nuclear submarines (SSBNs), although the AN/BQQ-5 systems installed on Ohio Class SSBNs do not have an active sonar capability. The AN/BQQ-5 system is being phased out on all submarines in favor of the AN/BQQ-10 sonar.

In addition, Seawolf Class attack submarines, Virginia Class attack submarines, Los Angeles Class attack submarines, and Ohio Class nuclear guided missile submarines also have the AN/BQS-15 sonar system, which uses high-frequency for under-ice navigation and mine-hunting. However, Navy submarines would use this sonar system only when entering and leaving a port. As a result, we would not expect endangered marine mammals to be exposed to this sonar system, although sea turtles that occur in the ports might be exposed to active sonar from this system.

Sonar Systems Associated with Aircraft.

As discussed in the *Description of the Proposed Action*, aircraft sonar systems that typically operate during Navy training exercises include sonobuoys and dipping sonar. Current dipping sonar systems used by the Navy are either AN/SQS-22 or AN/AQS -13. AN/AQS -13 is an older and less powerful dipping sonar system (maximum source level 215 dB re μPa-s2 at 1m) than the AN/AQS -22 (maximum source level 217 dB re μPa-s2 at 1m). In its modeling, the Navy assumed that all dipping sonar were AN/AQS -22. P-3 aircraft may deploy sonobuoys while helicopters may deploy sonobuoys or dipping sonars (the latter are used by carrier-based helicopters). Sonobuoys are expendable devices used by aircraft for the detection of underwater acoustic energy and for conducting vertical water column temperature measurements. Dipping sonar is an active or passive sonar device lowered on cable by helicopters to detect or maintain contact with underwater targets. In addition, the U.S. Navy employs tonal sonobuoys (DICASS, AN/SSQ-62) and the Improved Extended Echo Ranging (IEER) System discussed in the *Description of the Proposed Action*.

1. The AN/SSQ-62C Directional Command Activated Sonobuoy System (DICASS) sonar system is part of a sonobuoy that operates under direct command of fixed-wing aircraft or helicopters. The system can determine the range and bearing of the target relative to the sonobuoys position and can deploy to various depths within the water column. After it enters the water, the sonobuoy transmits sonar pulses (continuous waveform or linear frequency modulation) upon command from the aircraft. The echoes from the active sonar signal are processed in the buoy and transmitted to the receiving station onboard the launching aircraft.

2. AN/SSQ-110A Explosive Source Sonobuoy – a commandable, air-dropped, high source level explosive sonobuoy. The AN/SSQ-110A explosive source sonobuoy is composed of two sections, an active (explosive) section and a passive section. The upper section is called the "control buoy" and is similar to the upper electronics package of the AN/SSQ-62 DICASS sonobuoy. The lower section consists of two signal underwater sound explosive payloads of Class A explosive weighing 1.9 kg (4.2 lbs) each. The arming and firing mechanism is hydrostatically armed and detonated. Once in the water, the water pressure triggers the underwater sound charges to explode, creating a loud acoustic signal. The echoes from the explosive charge are then analyzed on the aircraft to determine a submarine's position. The AN/SSQ-110A explosive source sonobuoy is deployed by maritime patrol aircraft.

3. AN/SSQ-125 Advanced Extended Echo Ranging (AEER) Sonobuoy - a third generation of multi-static active acoustic search systems to be developed under the Extended Echo Ranging family of the systems and is being developed as the replacement for the AN/SSQ-110A. The AN/SSQ-125 sonobuoy is composed of two sections, the control section and the active source section. The control section is similar to the upper electronics package of the AN/SSQ-62 DICASS sonobuoy. The lower section consists of the active sonar source. The echoes from pings

of the sonar are then analyzed on the aircraft to determine a submarine's position. The AN/SSQ-125 sonobuoy will be deployed by maritime patrol aircraft.

Torpedoes

Torpedoes (primarily MK-46 and MK-48) are the primary anti-submarine warfare weapon used by surface ships, aircraft, and submarines. The guidance systems of these weapons can be autonomous or electronically controlled from the launching platform through an attached wire. The autonomous guidance systems are acoustically based. They operate either passively, exploiting the emitted sound energy by the target, or actively ensonifying the target and using the received echoes for guidance.

In addition to these torpedoes, the U.S. Navy employs Acoustic Device Countermeasures in several of their training exercises. These countermeasures (which include MK-1, MK-2, MK-3, MK-4, noise acoustic emitter, and the AN/SLQ-25A NIXIE) act as decoys by making sounds that simulate submarines to avert localization or torpedo attacks.

Mine Warfare Sonar Systems

As discussed in the *Description of the Proposed Action*, the U.S. Navy uses a variety of different sonar systems during mine warfare training exercises. These sonar systems are typically high-frequency sonars (i.e., greater than 10 kHz) that detect, locate, and characterize moored and bottom mines and can be deployed by helicopters, unmanned underwater vehicles, surf zone crawlers, or surface ships. The majority of mine warfare systems are deployed by helicopters and typically operate at high (greater than 200 kHz) frequencies. The types of tactical acoustic sources used during mine warfare sonar training activities include the following:

SURFACE SHIP SONARS**.** Guided missile destroyers, fast frigates, and guided missile cruisers can use their hullmounted sonars (AN/SQS-53 and AN/SQS-56) in the object detection (Kingfisher) mode. These ships, as well as mine hunters, may utilize over-the-side unmanned underwater vehicle systems containing sonar sensor packages to detect and classify mine shapes.

SUBMARINE SONARS**.** Submarines can use a sail-mounted sonar, AN/BQS-15, to detect mines and objects. In addition, they employ the AN/BLQ-11 Long Term Mine Reconnaissance System which is an unmanned underwater vehicle that, when in operation, can be launched and recovered through the torpedo tubes by all classes of submarines. It can be equipped with mid-frequency active sonar to detect mines and is intended to extend a submarine's reach for mine reconnaissance missions.

In addition, the U.S. Navy employs active sonar systems from aircraft as part of its mine warfare scenarios. Two systems in particular – AN/AQS-14, which is an active-controlled, helicopter-towed mine-hunting active sonar and AN/AQS-24 which is an upgraded version of AN/AQS-14 – operate above 200 kHz.

The duration, rise times, and wave form of sonar transmissions that would be used during Navy training exercise are classified; however, the characteristics of the transmissions that were used during the Bahamas exercises might help illustrate attributes of the transmissions from these two sonar sources. During the Bahamas exercises, these two sonars transmitted 1 – 2 second pulses once every 24 seconds (D'Spain *et al.* 2006). Pulses had rise times of 0.1 –0.4 seconds and typically consisted of three waveforms with nominal bandwidths up to 100 Hz (D'Spain *et al.* 2006). Both sonar create acoustic fields that are omnidirectional in azimuth, although AN/SQS-53 also can create beams covering 120^{o} azimuthal sectors that can be swept from side to side during transits (D'Spain *et al.* 2006). Waveforms of both sonar systems are frequency modulated with continuous waves (D'Spain *et al.* 2006).

Sound Propagation

Near an ocean's surface (roughly the uppermost 150 feet), the sound field will be normally dominated by sound generated by wave action, rain, and other surface activity; that would mask most anthropogenic sounds. Below the surface area of this mixed layer, depth (pressure) dominates the sound speed profile and the sound's speed *increases* with depth. Below the mixed layer, sea temperatures drop rapidly in an area referred to as the thermocline. In this region, temperature dominates the sound speed profile and speed decreases with depth. Finally, beneath the thermocline, the temperature becomes fairly uniform and increasing pressure causes the sound speed profile to increase with depth.

Acoustic waveguides, which include surface ducts as well as the SOFAR (sonar fixing and ranging) channel and deep sound channel of deep waters, focus sound from sources within the waveguide to long ranges. Surface ducts are acoustic waveguides that occur in the uppermost part of the water column when water near the surface are mixed by convection by surface wave activity generated by atmospheric winds. This mixing forms a surface layer with nearly constant temperatures so that sound speeds in the layer increase with depth. If sufficient energy is subsequently reflected downward from the surface, the sound can become "trapped" by a series of repeated upward refractions and downward reflections to create surface ducts or "surface channels". Surface ducts commonly form in the winter because the surface is cooled relative to deeper water; as a result, surface ducts are predictable for certain locations at specific times of the year.

Table 14. Description and attributes of sonar sources proposed for use along the Atlantic Coast of the United States

System	Center Frequency (kHz)	Source Level (re 1 µPa)	Associated Platform	System Description	Annual Quantity	Unit
AN/SQS-53	3.5	235	DDG and CG hull-mounted sonar (surface ship)	ASW search, detection, & localization; utilized 70% in search mode and 30% track mode	3214	Hours
AN/SQS-56	7.5	225	FFG hull-mounted sonar (surface ship)	ASW search, detection, & localization; Utilized 70% in search mode and 30% track mode	1684	Hours
AN/SQS-53 and AN/SQS-56 (Kingfisher)	MF	Classified	DDG, CG, and FFG hull-mounted sonar (object detection)	Only used when entering and leaving port	216	Hours
AN/BQQ-5 or 10****	MF	Classified	Submarine hull-mounted sonar	ASW search and attack (approximately one ping per two hours when in use)	9976	Pings
AN/AQS-13	10	215	Helicopter dipping sonar	ASW sonar lowered from hovering helicopter (approximately 10 pings/dip, 30 seconds between pings)	1476	Dips
AN/AQS-22	4.1	217	Helicopter dipping sonar	ASW sonar lowered from hovering helicopter (approximately 10 pings/dip, 30 seconds between pings)	1476	Dips
MK-48 Torpedo	HF	Classified	Submarine fired exercise torpedo	ASW sonar lowered from hovering helicopter (approximately 10 pings/dip, 30 seconds between pings)	32	Torpedoes
MK-46 or 54 Torpedo	HF	Classified	Surface ship and aircraft fired exercise torpedo	Recoverable and non-explosive exercise torpedo; sonar is active approximately 15 min per torpedo run	24	Torpedoes
Tonal sonobuoy (DICASS) (AN/SSQ-62)	8	201	Helicopter and MPA deployed	Remotely commanded expendable sonar-equipped buoy (approximately 12 pings per use, 30 secs between pings)	5853	Buoys
IEER (AN/SSQ-110A)	Impulsive - Broadband	Classified	MPA deployed	ASW system consists of explosive acoustic source buoy (contains two 4.1 lb charges) and expendable passive receiver sonobuoy	1725	Buoys
AN/SLQ-25 (NIXIE)	MF	Classified	DDG, CG, and FFG towed array (countermeasure)	Towed countermeasure to avert localization and torpedo attacks (approximately 20 mins per use)	2500	Hours
AN/BQS-15	HF	Classified	Submarine navigational sonar	Only used when entering and leaving port	450	Hours
ADC MK-1, MK-2, MK-3, and MK-4 ADCs**	MF	Classified	Submarine deployed countermeasure	Expendable acoustic device countermeasure (approximately 20 mins per use)	225	ADCs
Noise Acoustic Emitters (NAE)	MF	Classified	Submarine deployed countermeasure	Expendable acoustic countermeasure (20 mins per use)	127	NAEs
AN/SSQ-125	MF	Classified	MPA deployed	ASW system consists of active sonobuoy and expendable passive receiver sonobuoy	1550	Buoys

Table 15. Training scenarios and the number of activities associated with those scenarios, by operating area

Training Scenario	Operating Area					
	Northeast	Virginia Capes	Cherry Point	Jacksonville – Charleston	Gulf of Mexico	Totals
Independent Unit-Level Training						
Surface Ship ASW	-	69	91	292	5	**457**
Surface Ship Object Detection/Navigational Sonar	-	68	-	40	-	**108**
Helicopter ASW	-	25	25	115	-	**165**
Submarine ASW	30	10	14	45	1	**100**
Submarine Object Detection/Navigational Sonar	165	78	-	57	-	**300**
Maritime Patrol Aircraft ASW (tonal sonobuoy)	238	79	111	356	7	**791**
Maritime Patrol Aircraft ASW (explosive source sonobuoy)	34	34	34	34	34	**170**
Surface Ship Mine Warfare Exercise	-	-	-	-	266	**266**
Coordinated Unit-Level Training						
SEASWITI	-	-	-	4	-	**4**
IAC	-	0.2	1.4	2.4	1	**5**
Group Sail	-	3	4	13	-	**20**
SCC Operations	0.4	-	-	1.6	-	**2**
RONEX and GOMEX Exercises	-	-	-	-	8	**8**
Strike Group Training						
ESG and CSG Composite Training Unit Exercise	-	0.2	1.4	2.4	1	**5**
Joint Task Force Exercise	-	0.2	0.6	1.2	0	**2**
Maintenance						
Surface Ship Sonar Maintenance	-	61	82	263	4	**410**
Submarine Sonar Maintenance	30	10	14	45	1	**100**
Event Totals	**497.4**	**437.6**	**378.4**	**1271.6**	**328**	**2913**

Sound trapped in a surface duct can travel for relatively long distances with its maximum range of propagation dependent on the specifics of the sound speed profile, the frequency of the sound, and the reflective characteristics of the surface. As a general rule, surface duct propagation will increase as the temperature becomes more uniform and depth of the layer increases. For example, a sound's transmission is improved when windy conditions create a well-mixed surface layer or in high-latitude midwinter conditions where the mixed layer extends to several hundred feet deep.

5.1.7 Explosive Source associated with the Improved Extended Echo Ranging (IEER) System

One of the systems the U.S. Navy proposes to employ as part of the proposed active sonar training include explosive charges that provide a sound source. The AN/SSQ-110A Explosive Source Sonobuoy is composed of two sections, an active (explosive) section and a passive section. The lower, explosive section consists of two signal underwater sound explosive payloads of Class A explosive weighing 1.9 kg (4.2 lbs) each. The arming and firing mechanism is hydrostatically armed and detonated. Once in the water, the signal underwater sound charges explode, creating a loud acoustic signal.

The number of endangered or threatened species that might be exposed to explosions associated with this ordnance treat each in-water explosion as an independent event. The cumulative effect of a series of explosives can often be estimated by addition if the detonations are spaced widely in time and space which would provide marine animal' sufficient time to move out of an area affected by an explosion. As a result, the populations of animals that are exposed to in-water explosions are assumed to consist of different animals each time.

5.1.8 Parachutes Released During Deployment of Sonobuoys

When AN/SQS-62 DICASS sonobuoys impact the water surface after being deployed from aircraft, their parachute assemblies of sonobuoys are jettisoned and sink away from the sonobuoy, while a float containing an antenna is inflated. The parachutes are made of nylon and are about 8 feet in diameter. At maximum inflation, the canopies are between 0.15 to 0.35 square meters (1.6 to 3.8 squared feet). The shroud lines range from 0.30 to 0.53 meters (12 to 21 inches) in length and are made of either cotton polyester with a 13.6 kilogram (30 pound) breaking strength or nylon with a 45.4 kilogram (100 pound) breaking strength. All parachutes are weighted with a 0.06 kilogram (2 ounce) steel material weight, which would cause the parachute to sink from the surface within about 15 minutes, although actual sinking rates depend on ocean conditions and the shape of the parachute.

The subsurface assembly descends to a selected depth, and the sonobuoy case falls away and sea anchors deploy to stabilize the hydrophone (underwater microphone). The operating life of the seawater battery is eight hours, after which the sonobuoy scuttles itself and sinks to the ocean bottom. For the sonobouys, concentrations of metals released from batteries were calculated to be 0.0011 mg/L lead, 0.000015mg/L copper, and 0.0000001mg/L silver.

5.2 Exposure and Response Analyses

As discussed in the *Approach to the Assessment* section of these Opinions, our exposure analyses are designed to determine whether listed resources are likely to co-occur with the direct and indirect beneficial and adverse effects of actions and the nature of that co-occurrence. In this section of this biological opinion, we present the results of our exposure analyses, which are designed to identify the number, age (or life stage), and gender of the individuals that are likely to be exposed to one or more of the stressors produced by or associated with an Action and the populations or subpopulations those individuals represent.

As discussed in the *Approach to the Assessment* section of these Opinions, the U.S. Navy, NMFS, and most other entities (for example, oil and gas industries for drilling platforms, geophysics organizations that conduct seismic surveys, etc.) rely on computer models, simulations, or some kind of mathematical algorithm to estimate the number of animals that might be exposed to a sound source. Like all models, these approaches are based on assumptions and are sensitive to those assumptions. Based on our evaluation of assumptions the U.S. Navy incorporates in its models, those models would tend to over-estimate the number of marine mammals that might be exposed to military readiness activities in waters on and adjacent to the East Coast Range Complexes because (1) those models assume that marine mammals would not try to avoid being exposed to the sound field associated with active sonar or would not try to avoid continued exposure to the sound field; (2) those models assume that mean densities of marine mammals within any square kilometer area of the East Coast Range Complexes would be constant over time (that is, the models assume that the probability of marine mammals occurring in any square kilometer area over any time interval is 1.0, when, in fact, the probability would be much smaller than 1.0; this difference would tend to overestimate the number of animals in the action area during shorter time intervals).

The following narratives present the results of the exposure analyses we conducted for the military readiness activities the U.S. Navy proposes to conduct on the Northeast, Virginia Capes, Cherry Point, and Jacksonville Range Complexes from June 2011 through June 2012. The narratives that follow present the results of (1) the method we used to estimate the number of endangered or threatened species NMFS used (which is described in the *Approach to the Assessment* section of these Opinions) and (2) the approach the U.S. Navy and NMFS' Permits Division used to estimate the number of marine mammals that might be "taken" (as that term is defined pursuant to the MMPA) during active sonar training activities the U.S. Navy proposes to conduct and NMFS' Permits Division (which is also described in the *Approach to the Assessment* section of thes e Opinions). Before we present those results, however, we discuss whether and to what degree the measures the U.S. Navy proposes to implement or that the Permits Division proposes to include in its proposed MMPA authorization would be expected to avoid or minimize the number of endangered or threatened species that might otherwise be exposed to the U.S. Navy‘s training activities on the East Coast Range Complexes.

As discussed in the preceding section on *Stressors* that would be associated with the proposed action and the interrelated Atlantic Fleet Active Sonar Training activities, the U.S. Navy estimated that the proposed training activites would result in about 1,420 steaming days per year in the Virginia Capes Range Complex, 950 steaming days in the Cherry Point Range Complex, and 1,050 steaming days in the Jacksonville Range Complex. Vessel movements unrelated to training activities — for example, for storm evasion, deployment transits, and movements in basins to rearrange ships for repairs, berthing, loading, and off-loading from designated piers — would increase these estimates. With the Transit Protection System the U.S. Navy proposes to employ at Kings Bay, Georgia, the U.S. Navy would employ up to 16 escort security boats that would engage in between 130 to 170 events per year or 10 to 15 times per month.

The ships involved in the proposed training activities would range in size from 362 feet (a nuclear submarine) to 1,092 feet (for a nuclear-powered aircraft carrier). A variety of smaller craft such as service vessels engaged in routine operations or employed as opposition forces during training events would also be operating within the different range complexes. During training activities, ship speeds generally range from 10 to 14 knots; however, these vessels would also operate within the entire spectrum at higher speeds during specific events, such as pursuing and overtaking hostile vessels, evasive maneuvers, and maintenance or performance checks (such as ship trials). The size and speeds of smaller vessels would vary. For example, rigid hull inflatable boat Warfare RHIBis 35 feet in length and has a speed greater than 40 knots.

PROBABILITY OF AN ENCOUNTER (A COLLISION). Despite the significant risks ship strikes pose for endangered and threatened whales and sea turtles, only a few methods to estimate the probability of encounters between whales and ships are available. Of these, the methodology developed by Vanderlaan and her co-authors (2008) seems the most relevant: they developed a method for estimating the probability of an encounter between North Atlantic right whales and surface vessels in the Bay of Fundy and the Scotia Shelf, including an encounter that results in the death of a whale. That method would require us to estimate the probability of an encounter between a whale and a ship (which is a function of the relative probability of a whale occurring in a particular cell and the probability of a ship occurring in the same cell) and the probability of an encounter being lethal if it occurred (which is a function of the vessel's speed). We could use the equation they proposed to estimate the probability of an encounter between a Navy vessel and a right whale being lethal for the whale[15], but we do not have the information necessary to use the approach Vanderlaan and her co-authors developed to estimate the probability of a whale encountering a vessel.

Nevertheless, U.S. Navy vessels have struck and killed several whales along the Atlantic Coast of the United States, including whales that are listed as endangered. Of the 134 records of ship strikes involving

[15] Vanderlaan and her co-authors (2008) calculated the probability of an encounter being lethal as: [Pr(Lethal|Encounter)] = 1/[1+exp-(-4.89+0.41x)] where x is the mean vessel speed, in knots, in a particular cell. This equation presupposed an estimate of the probability of an encounter.

large whales, 23 represented reports of whales having been struck by U.S. Navy vessels (Jensen and Silber 2004). Seven of these 23 records represented whales that had been struck by Navy vessels along the Atlantic coast, from Canada south to Key West, Florida, between 1945 and 2001. Two of these seven records represented minke whales, one record represented either a minke or small sei whale, a fourth record represented a sperm whale, and the species involved in the remaining three records were unknown.

More recently, a Navy amphibious assault ship struck a large whale off the Chesapeake Light House on 17 November 2004. A few hours later, around noon, the Virginia Aquarium stranding hotline received a report of a live injured large whale with a fresh wound on the tail where the left fluke lobe was missing. On 24 November 2004, a pregnant female right whale was necropsied at Ocean Sands, North Carolina; the necropsy concluded that the right whale had died from blood loss caused by a traumatic wound to her left fluke lobe (which was missing) and damage to surrounding tissue and bone. The necropsy concluded that the wound was consistent with a wound caused by a ship strike. The information available, however, does not allow us to determine whether or not the right whale had been struck by the Navy vessel. Nevertheless, we could rule out several of the large whales that occur in the eastern Atlantic Ocean — Bryde's, blue, sei, and sperm whales — because they are not likely to occur in waters off the Chesapeake Bay Lighthouse; as a result, the whale was probably either a fin, humpback, minke, or right whale.

A vessel cannot strike an animal that it does not encounter. To gain insight into the number of whales U.S. Navy vessel might encounter, we analyzed data from eight after-action-reports the U.S. Navy submitted on major training exercises it conducted from the summer of 2006 through the summer of 2008 within the Cherry Point and Charleston Operating Areas and portions of the Jacksonville and Virginia Capes Operating Areas. U.S. Navy watchstanders reported sightings of whales in 3 of the 8 exercises (probability of an encounter during an exercise = 0.3750) and sightings of sea turtles in 1 of the 8 exercises (probability of an encounter during an exercise = 0.1250); during three of these eight training exercises, the U.S. Navy reported no sightings of either whales, small cetaceans, or sea turtles. Of the four major training exercises in which marine mammals or sea turtles were sighted, the mean number of sightings was 1.235 per day or 0.0515 sightings per hour. About 12 percent of these sightings were made at distances greater than 1,000 meters (maximum reported distance was 10,000 yards), which would lead us to conclude that a whale is not likely to be struck if it is observed by U.S. Navy watchstanders.

If we assume that the annual number of steaming days U.S. Navy vessels engaged in during 2006 and 2007 were representative of the annual number of steaming days between 1945 and 2011 (this assumption is almost certainly incorrect, but we do not have data on the number of steaming days over the entire 60-year period to apply to this question) and use the number of whales the Navy has struck over that 60-year time interval to estimate the probability of a collision in the future, Navy vessels would have a 0.0000472 probability of striking a whale in any year over the next five years or a probability of 0.000236 over the five-year period. With an estimated 3,450 steaming days per year, U.S. Navy vessels have a 99.99 percent probability of *not* striking a whale in any given year or a 99.97 percent probability of *not* striking a whale over the five-year period of the MMPA regulations. Although these probabilities are sufficiently small for us to conclude that a strike is "not likely", we would not be able to conclude that a strike would be impossible over the next five years

MITIGATION MEASURES TO MINIMIZE THE LIKELIHOOD OF COLLISIONS WITH VESSELS. The U.S. Navy proposes to employ a number of measure to avoid striking a whale; in the discussions that follow, we consider those measures and consider whether individual measures or the entire set are likely to reduce the probability of (1) a Navy vessel striking a whale over the one-year period of the proposed Letters of Authorization and (2) killing a whale that has been struck.

Vanderlaan *et al*. (2008) argued that the two most simple and practical methods of reducing the probability of a vessel striking and killing a whale are (1) altering vessel traffic routing in and around known whale habitats to reduce a vessel's probability of encountering a whale or (2) reducing vessel speeds to reduce the whale's probability of being killed if it is struck by a vessel. They argued that only the vessel re-routing option would reduce the likelihood of exposing marine mammals to vessels that are underway. The U.S. Navy, however, proposes another option that consists of:

1. avoiding training in specific areas that are important to North Atlantic right whales;

Specifically, the U.S. Navy does not plan to conduct active sonar activities within the Stellwagen Bank, Monitor, Gray's Reef, Flower Garden Banks, or Florida Keys National Marine Sanctuaries and has proposed to avoid these sanctuaries by observing a 5 km (2.7 nautical mile or nm) buffer around those areas. In addition, the only kind of exercise the U.S. Navy plans to conduct inside the critical habitat that has been designated for North Atlantic right whales off the southeast coast of the United States and Associated Area of Concern (the area extending 5 nm seaward of the boundaries of the critical habitat designation) during the calving season for right whales would be precision anchorage drills, swept channel exercises and maritime security exercises. In addition, Navy vessels in the designated critical habitat would be able to employ the Shipboard Electronic System Evaluation Facility range with clearance and advice from Fleet Area Control and Surveillance Facility-Jacksonville.

2. avoiding training in specific areas during times when right whales are likely to occur in those areas;

3. ensuring that U.S. Navy vessels are aware of the large-scale distribution of whales in the areas in which training activities would occur and avoid the areas in which whales have been reported;

FACSFAC JAX would advise ships of all reported whale sightings in the vicinity of the critical habitat and Associated Area of Concern prior to conducting surface ship object detection exercises in the southeast North Atlantic right whale critical habitat from 15 November to 15 April. To the extent operationally feasible, Navy ships would avoid conducting training in the vicinity of recently sighted right whales. Navy ships would maneuver to maintain at least 457 m (500 yd) separation from any observed whale, consistent with the safety of the ship (these requirements would not apply if a vessel's safety were threatened, such as when change of course would create an imminent and serious threat to person, vessel, or aircraft, and to the extent vessels are restricted in the ability to maneuver).

Navy aircraft participating in exercises at sea would conduct and maintain, when operationally feasible and safe, surveillance for marine species of concern as long as it does not violate safety constraints or interfere with the accomplishment of primary operational duties.

When whales have been sighted in the area, Navy vessels would increase vigilance and take reasonable and practicable actions to avoid collisions and activities that might result in close interaction of naval assets and marine mammals. Actions may include changing speed and/or direction and are dictated by environmental and other conditions (*e.g.*, safety, weather).

Prior to transiting the Great South Channel or Cape Cod Bay critical habitat areas, ships would obtain the latest right whale sightings and other information needed to make informed decisions regarding safe speed. Any vessel operating in the vicinity of a North Atlantic right whale shall consider additional speed reductions as per Rule 6 of International Navigational Rules. The Great South Channel critical habitat is defined by the following coordinates: 41°00N, 69°05W; 41°45N, 69°45W; 42°10N, 68°31W; 41°38N, 68°13W. The Cape Cod Bay critical habitat is defined by the following coordinates: 42°04.8N, 70°10W; 42°12N, 70°15W; 42°12N, 70°30W; 41°46.8N, 70°30W.

During the time intervals identified in Table 16, U.S. Navy vessels would practice increased vigilance with respect to avoidance of vessel-whale interactions along the mid-Atlantic coast, including transits to and from any mid-Atlantic ports not specifically identified above. All surface (d) units transiting within 56 km (30 nm) of the coast in the mid-Atlantic would ensure at least two watchstanders are posted, including at least one lookout that has completed required Marine Species Awareness Training.

Table 16. North Atlantic Right Whale Migration Port References

Region	Months	Port Reference Points
South and East of Block Island	September–October and March–April	20 nm seaward of line between 41°4.49N to 71°51.15W and 41°18.58N to 70°50.23W
New York / New Jersey	Sep–Oct and Feb-Apr	40°30.64N to 73°57.76W
Delaware Bay (Philadelphia)	Oct–December and February–March	38°52.13N to 75°1.93W
Chesapeake Bay (Hampton Roads and Baltimore)	November-December and February–April	37°1.11N to 75°57.56W
North Carolina	December–April	34°41.54N to 76°40.20W
South Carolina	October–April	33°11.84N to 79°8.99W 32°43.39N to 79°48.72W

During calving season and within the consultation area (roughly an area to 80 nm seaward from Charleston, South Carolina, south to Sebastian Inlet, Florida) particular measures remain in effect in accordance with NMFS' 1997 Biological Opinion on U.S. Navy training activities off the southeastern United States (NMFS 1997). The U.S. Navy proposes to continue implementing the following measures from that biological opinion during the North Atlantic right whale calving season (November 15 – April 15):

3.1 Naval vessels operating within North Atlantic right whale critical habitat [16] and the Associated Area of Concern would exercise extreme caution and use slow safe speed, that is, the slowest speed that is consistent with essential mission, training, and operations.

3.2 Exercise extreme caution and use slow, safe speed when a whale is sighted by a vessel or when the vessel is within 5 nm of a reported new sighting less than 12 hours old.

3.3 Circumstances could arise where, in order to avoid North Atlantic right whale(s), speed reductions could mean vessels must reduce speed to a minimum at which it can safely keep on course (bare steerageway) or vessels could come to an all stop.

3.4 During the North Atlantic right whale calving season north-south transits through the critical habitat are prohibited, except for those exercises that necessarily operate at a slow, safe speed. Naval vessel transits through the area shall be in an east-west direction, and shall use the most direct route available during the calving season.

3.5 Naval vessel operations in the North Atlantic right whale critical habitat and Associated Area of Concern during the calving season would be undertaken during daylight and periods of good visibility, to the extent practicable and consistent with mission, training, and operation. When operating in the critical habitat and Associated Area of Concern at night or during periods of poor visibility, vessels would operate as if in the vicinity of a recently reported North Atlantic right whale sighting.

3.6 Fleet Area Control and Surveillance Facility-Jacksonville shall coordinate ship/aircraft clearance into the operating area based on prevailing conditions, including water temperature, weather conditions, whale sighting data, mission or event to be conducted and other pertinent information. Commander Submarine Atlantic (COMSUBLANT) would coordinate any submarine operations that may require clearance with Fleet Area Control and Surveillance Facility-Jacksonville. Fleet Area Control and Surveillance Facility-Jacksonville would provide data to ships and aircraft,

[16] This critical habitat is the area from 31-15N to 30-15N extending from the coast out to 28 km (15 nm), and the area from 28-00N to 30-15N from the coast out to 9 km (5 nm).

including U.S. Coast Guard if requested, and would recommend modifying, moving or canceling events as needed to prevent whale encounters. Commander Submarine Group Ten (COMSUBGRU TEN) would provide same information/guidance to subs.

3.7 Fleet Area Control and Surveillance Facility-Jacksonville would coordinate local procedures for whale data entry, update, retrieval and dissemination using joint maritime command information system. Ships not yet Officer in Tactical Command Information Exchange subsystem capable, including U.S. Coast Guard, would communicate via satellite communication, high frequency, telephone or international marine/maritime satellite.

4. Ensuring that U.S. Navy vessels are aware of whales that occur within the vicinity of their vessel or are likely to detect whales that occur in their vicinity and avoid whales they detect; .

All surface units transiting within 30 nm (55 km) of the coast in the mid-Atlantic would ensure at least two watchstanders are posted, including at least one lookout that has completed required marine mammal awareness training. While underway, surface vessels would have at least two lookouts with binoculars; surfaced submarines would have at least one lookout with binoculars. Lookouts already posted for safety of navigation and man-overboard precautions may be used to fill this requirement. As part of their regular duties, lookouts would watch for and report to the Officer of the Deck the presence of marine mammals and sea turtles.

Prior to transiting or training in the critical habitat ships would contact Fleet Area Control and Surveillance Facility-Jacksonville to obtain latest whale sighting and other information needed to make informed decisions regarding safe speed and path of intended movement. Submarines shall contact Commander Submarine Group Ten for similar information. Ships and aircraft desiring to train/operate inside the critical habitat or within the warning/operating area shall coordinate clearance with Fleet Area Control and Surveillance Facility-Jacksonville. Submarines shall obtain same clearance from CTF-82 (Commander Submarine Atlantic).

U.S. Naval vessels would maneuver to keep at least 500-yd (460 m) away from any observed whale and avoid approaching whales head-on. This requirement would not apply if a vessel’s safety were threatened, such as when 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. Restricted maneuverability includes, but is not limited to, situations when vessels are engaged in dredging, submerged operations, launching and recovering aircraft or landing craft, minesweeping operations, replenishment while underway and towing operations that severely restrict a vessel’s ability to deviate course. Vessels would take reasonable steps to alert other vessels in the vicinity of the whale.

Navy vessels would avoid knowingly approaching any whale head on and would maneuver to keep at least 1,500 ft (460 m) away from any observed whale, consistent with vessel safety.

Where feasible and consistent with mission and safety, vessels would avoid closing to within 200 yards (183 m) of sea turtles and marine mammals other than whales.

Floating weeds, algal mats, *Sargassum* rafts, clusters of seabirds, and jellyfish are good indicators of sea turtles and marine mammals. Therefore, U.S. Navy vessels would employ increased vigilance in watching for sea turtles and marine mammals where those indicators are present.

5. Reducing the speeds of U.S. Navy vessels that are in areas in which whales have been reported or whales those vessels detect.

While in transit, naval vessels would be alert at all times, use extreme caution, and proceed at a “safe Speed” so that the vessel can take proper and effective action to avoid a collision with any marine animal and could be stopped within a distance appropriate to the prevailing circumstances and conditions.

When transiting within the critical habitat that has been designated for North Atlantic right whales off the southeastern United States or Associated Area of Concern, vessels would be required to use extreme caution and operate at a safe speed so as to be able to avoid collisions with North Atlantic right whales and other marine mammals, and stop within a distance appropriate to the circumstances and conditions. Speed reductions (adjustments) would be required when a whale is sighted by a vessel or when the vessel is within 9 km (5 nm) of a reported new sighting less than one week old.

We would not expect vessel traffic associated with the Transit Protection System the U.S. Navy proposes to employ at King’s Bay, Georgia (up to 16 escort security boats that would engage in between 130 to 170 events per year or 10 to 15 times per month) to represent a risk of ship strikes because the escort vessels are small and are deployed to insure the safety of the submarines they escort. Because of that mission, those vessels seem likely to detect any whales in the transit area and avoid or prevent those whales from colliding with the submarine and any escort vessels.

Mitigation Measures to Minimize the Likelihood of Exposing Listed Species to Mid-Frequency Active Sonar.

Because the U.S. Navy does not plan to conduct active sonar training activities within the Stellwagen Bank, Monitor, Gray’s Reef, Flower Garden Banks, and Florida Keys National Marine Sanctuaries and will avoid these sanctuaries by observing a 5 km (2.7 nautical mile or nm) buffer, individual endangered or threatened animals that occur in these areas would not be exposed to mid-frequency active sonar at received levels greater than about 170 dB (based on estimates of propagation distances and assuming that a vessel near the boundary of this buffer zone would be transmitting active sonar).

Because the U.S. Navy did not propose to conduct active sonar training in North Atlantic right whale critical habitat with the exception of object detection and navigation off shore Mayport, Florida and Kings Bay, Georgia; helicopter anti-submarine warfare training activities offshore Mayport, Florida; and torpedo exercises in the northeast during the months of August and September, any endangered or threatened species that occur in designated critical habitat off Massachusetts would not be exposed to high received levels of active sonar.

Outside of these areas, the U.S. Navy proposes to implement a suite of mitigation measures to prevent marine mammals from being exposed to mid frequency active sonar at high received levels, primarily relying on Navy lookouts, helicopter pilots, and other Navy assets to visually detect marine mammals so that the Navy can take actions that are appropriate based on these detections. To the degree that the Navy detects marine mammals visually, these safety zones might reduce the number of marine mammals that are exposed to mid-frequency active sonar or the intensity of their exposure. However, the effectiveness of visual monitoring is limited to daylight hours, and its effectiveness declines during poor weather conditions (JNCC 2004). In line transect surveys, the range of effective visual sighting (the distance from the ship's track or the *effective strip width*) varies with an animal's size, group size, reliability of conspicuous behaviors (blows), pattern of surfacing behavior, and positions of the observers (which includes the observer‘s height above the water surface). For most large baleen whales, effective strip width can be about 3 km (1.6 nm) up through Beaufort 6 (Buckland *et al.* 1993). For harbor porpoises the effective strip width is about 250 m (273 yd), because they are much smaller and less demonstrative on the surface than baleen whales (Palka 1996).

Further, several studies of interactions between seismic surveys and marine mammals and a proposed low-frequency active sonar system and marine mammals concluded that dedicated marine mammal observers were more effective at detecting marine mammals, were more effective at detecting marine mammals at greater distances than Navy watchstanders (watchstanders of the Navies of other countries), were better at identifying the marine mammal to species, and reported a broader range of behaviors than other personnel (Aicken *et al.* 2005; Stone 2000, 2001,2003). It is not clear, however, how the U.S. Navy's watchstanders and marine species observers, who are specifically trained to identify objects in the water surrounding Navy vessels compare with observers who are specifically trained to detect and identify marine mammals in marine water. NMFS is working with the Navy to determine the effectiveness of this component of Navy monitoring program and the degree to which it is likely to minimize the probability of exposing marine mammals to mid-frequency active sonar.

A multi-year study conducted on behalf of the United Kingdom's Ministry of Defense (Aicken *et al.* 2005) concluded that Big Eye binoculars were not helpful. Based on these studies, we would conclude that requiring surface vessels equipped with mid-frequency active sonar to have Big Eye binoculars in good working order is not likely to increase the number of marine mammals detected at distances sufficient to avoid exposing them to received levels that might result in adverse consequences.

The percentage of marine animals Navy personnel would not detect, either because they will pass unseen below the surface or because they will not be seen at or near the ocean surface, is difficult to determine.

However, for minke whales, Schweder *et al.* (1992) estimated that visual survey crews did not detect about half of the animals in a strip width. Palka (1996) and Barlow (1988) estimated that visual survey teams did not detect about 25 percent of the harbor porpoises in a strip width. The information available leads us to conclude that the combinations of safety zones triggered by visual observations would still allow most marine mammals and sea turtles to be exposed to midfrequency active sonar transmissions because most marine animals will not be detected at the ocean's surface.

Mitigation Measures to Minimize the Likelihood of Exposing Listed Species to Underwater Detonations.

During the sinking exercises, the U.S. Navy proposes to conduct on the Northeast, Virginia Capes, Cherry Point, and Jacksonville Range Complexes from June 2011 through June 2012, the U.S. Navy plans to incorporate the monitoring protocols associated with the shock trials of the USS *Winston Churchill*. These monitoring protocols were studied extensively and those studies concluded that these monitoring protocols effectively insured that marine mammals or sea turtles did not occur within 3.7 kilometers of the underwater detonations, which would prevent them from being exposed to shock waves at pressures that would cause serious injuries (Clarke and Norman 2005). By incorporating safety zones, monitoring, and shut down procedures similar to those associated with the *Winston Churchill* shock trials into the protocols for its proposed sinking exercises, the U.S. Navy should prevent marine mammals and sea turtles from being exposed to energy from underwater detonations associated with the two proposed sinking exercises the U.S. Navy plans to conduct on the East Coast Range Complexes each year for the next five year. Because they are likely to prevent endangered or threatened marine mammals and sea turtles from being exposed to shock waves or the sound fields associated with these exercises, endangered and threatened species that occur in the action area are not likely to be adversely affected by this component of the proposed action.

Blue Whale. Our analyses led us to the following conclusions about whether or to what degree blue whales might be exposed to vessel traffic, underwater detonations, and active sonar transmissions associated with the military readiness activities the U.S. Navy proposes to conduct on the east coast range complexes from June 2011 through June 2012:

Exposure to Vessel Traffic. We did not estimate the number of blue whales or other endangered or threatened whales that might be exposed to vessel traffic independent of the number of individuals that might be exposed to active sonar associated with those exercises because the data we would have needed to support those analyses were not available. Because of their seasonal occurrence, blue whales are likely to be exposed to vessel traffic associated with U.S. Navy training activities on the Northeast Range Complex during the summer months, but are not likely to be exposed to training exercises on the Virginia Capes, Cherry Point, or Jacksonville Range Complex; as a result, blue whales are more likely to be exposed to vessel traffic associated with unit-level training, which primarily involves single vessels.

Nevertheless, we assumed that any individuals of the endangered or threatened species that were likely to be exposed to active sonar at received levels sufficiently high to bring them close to the bow of Navy vessels moving at speeds would have some risk of being struck by the ship. For the purposes of these analyses, we assumed that a whale that occurred close enough to a Navy vessel (which would be moving at speeds greater than 14 knots) to experience temporary losses of hearing sensitivity as a result of its exposure to one or two pings would have some risk of being struck by the vessel. Based on the results of the Navy‘s models, we concluded that blue whales are not likely to occur close enough to a Navy vessel that is underway to have some risk of being struck by the vessel.

Exposure to Mid-frequency Active Sonar. Based on the U.S. Navy's exposure models, each year we would expect about 881 instances in which blue whales might be exposed to active sonar associated with AFAST training activities and be "taken" as a result of that exposure (see Table 17). All of these exposure events are likely to occur in the Northeast Operating Areas, which means they are likely to result from exposure to active sonar associated with submarines and maritime patrol aircraft (see Table 15).

Table 17. Expected number of instances in which individual members of endangered or threatened species are likely to be "taken" as a result of their exposure to active sonar during the Atlantic Fleet Active Sonar Training (AFAST) activities.

Species	Estimated Number of Instances in Which Species Would be "Taken"	Form of the "Take"
Blue whale	881	Harassment
Fin whale	970	Harassment
Humpback whale	4,622	Harassment
North Atlantic right whale	733	Harassment
Sei whale	1,163	Harassment
Sperm whale	10,734	Harassment

Probable Responses to Active Sonar Exposure. Blue whales are not likely to respond to high-frequency sound sources associated with the proposed training activities. Although blue whales appear to be able to hear midfrequency (1 kHz–10 kHz) sounds, sounds in this frequency range lie at the periphery of their hearing range and they are less likely to devote attentional resources to stimuli in this frequency range. Blue whales vocalizations include a variety of sounds described as low frequency moans or long pulses in the 10-100 Hz band (Cummings and Thompson 1971; Edds 1982; Thompson and Friedl 1982; McDonald *et al.* 1995; Clark and Fristrup 1997; Rivers 1997). The most typical signals are very long, patterned sequences of tonal infrasonic sounds in the 15-40 Hz range. Ketten (1997) 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. Blue 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 1971). The whale produced a short, 390 Hz pulse during the moan. Based on this information blue whales exposed to received levels of active mid-frequency sonar are not likely to respond physiologically or behaviorally to sounds in this frequency range.

Exposure and Probable Responses to Underwater Detonations. Because of their northern distribution, no blue whales are likely to be exposed to underwater detonations on the Virginia Capes, Cherry Point, or Jacksonville Range Complexes.

Fin Whale. Our analyses led us to the following conclusions about whether or to what degree fin whales might be exposed to vessel traffic, underwater detonations, and active sonar transmissions associated with the military readiness activities the U.S. Navy proposes to conduct on the east coast range complexes from June 2011 through June 2012:

Exposure to Vessel Traffic. We did not estimate the number of fin whales that might be exposed to vessel traffic independent of the number of individuals that might be exposed to active sonar associated with those exercises because the data we would have needed to support those analyses were not available. Because of their seasonal occurrence on the East Coast Range Complexes, fin whales are not likely to be exposed to training exercises that occur in the summer months, such as one of the joint multi-strike group exercises; as a result, they are more likely to be exposed to vessel traffic associated with unit-level training, which primarily involves single vessels.

Nevertheless, using the approach we just described for blue whales (see the preceding narrative) we assumed that two fin whales would occur close enough to a Navy vessel that is underway to have some risk of being struck by the vessel. Nevertheless, the low frequency of collisions between ships and large whales on the East Coast Range Complexes suggests that a collision is not likely to occur each time one of these whales occurs this close to a Navy vessels.

Exposure to Mid-frequency Active Sonar. Based on the U.S. Navy's exposure models, each year we would expect about 970 instances in which fin whales might be exposed to active sonar associated with AFAST training activities and be "taken" as a result of that exposure (see Table 17). Most of these exposure events are likely to occur in the Northeast Operating Areas, which means they are likely to result from exposure to active sonar associated with submarines and maritime patrol aircraft (see Table 15), with smaller numbers of exposure events on the Virginia Capes and Cherry Point Range Complexes.

Probable Responses to Active Sonar Exposure. Fin whales are not likely to respond to high-frequency sound sources associated with the proposed training activities and the evidence available suggests they are not likely to respond to mid-frequency sound sources as well. As discussed in the *Status of the Species* section of this Opinion, fin whales produce a variety of low-frequency sounds in the 10-200 Hz band (Watkins 1981; Watkins *et al.* 1987a; Edds 1988; Thompson *et al.* 1992). The most typical signals are long, patterned sequences of short duration (0.5-2s) infrasonic pulses in the 18-35 Hz range (Patterson and Hamilton 1964). Estimated source levels are as high as 190 dB (Patterson and Hamilton 1964; Watkins *et al.* 1987a; Thompson *et al.* 1992; McDonald *et al.* 1995). 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 (Clark and Charif 1998). Short sequences of rapid pulses in the 20-70 Hz band are associated with animals in social groups (McDonald *et al*. 1995). Each pulse lasts on the order of one second and contains twenty cycles (Tyack 1999). This information would lead us to conclude that fin whales exposed to these received levels of active mid-frequency sonar are not likely to respond if they are exposed to midfrequency (1 kHz–10 kHz) sounds.

The U.S. Navy's exposure models identified two instances in which fin whales might accumulate sufficient energy from active sonar to experience temporary noise-induced losses of hearing sensitivity. Despite the extensive amount of attention devoted to threshold shifts in the literature and environmental assessments, it is not certain that threshold shifts are as common in free-ranging animals as this level of attention might imply because free-raning 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 move 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 (Mooney *et al*. 2008, 2009).

Regardless, the data on captive animals and the limited information from free-ranging animals suggests that marine mammals would respond to temporary noise-induced hearing losses (also called "temporary threshold shift" or TTS) primarily through changes in their behavior while their ears recover from any temporary impairment (Box P2.2 of Figure 5 illustrates the potential consequences of noise-induced loss in hearing sensitivity). That is, the behavioral responses of fin whales that we have already presented would include behavioral changes in fin whales that might have experienced temporary noise-induced losses in hearing sensitivity.

Exposure and Probable Responses to Underwater Detonations. The U.S. Navy estimated that about 2 fin whales might be exposed annually to underwater detonations on the Virginia Capes Range Complex and experience behavioral harassment or noise-induced loss of hearing sensitivity as a result of that exposure. No fin whales are likely to be exposed to underwater detonations on the Cherry Point or Jacksonville Range Complexes

We would treat these exposure estimates to be minimal estimates because some fin whales are likely to be exposed to the sound fields produced by underwater detonations at lower received levels; that is, at received levels that would be expected to cause whales to change their behavioral state even if those changes in behavior might not qualify as "take" as that term is defined by the MMPA.

Humpback Whale. Our analyses led us to the following conclusions about whether or to what degree humpback whales might be exposed to vessel traffic, underwater detonations, and active sonar transmissions associated with the military readiness activities the U.S. Navy proposes to conduct on the east coast range complexes from June 2011 through June 2012:

Exposure to Vessel Traffic. Like blue and fin whales, we did not estimate the number of humpback whales that might be exposed to vessel traffic independent of the number of individuals that might be exposed to active sonar associated with those exercises because the data we would have needed to support those analyses were not available. Nevertheless, using the approach we just described for blue whales (see the preceding narrative) we assumed that fifty three humpback whales would occur close enough to a Navy vessel that is underway to have some risk of being struck by the vessel. Nevertheless, the low frequency of collisions between ships and large whales on the East Coast Range Complexes suggests that a collision is not likely to occur each time one of these whales occurs this close to a Navy vessels.

Exposure to Mid-frequency Active Sonar. Based on the U.S. Navy's exposure models, each year we would expect about 4,622 instances in which humpback whales might be exposed to active sonar associated with AFAST training activities and be "taken" as a result of that exposure (see Table 17). Unlike blue and fin whales, some of these exposure events are likely to occur in the Northeast Operating Areas and the Virginia Capes, Cherry Point, and Jacksonville Range Complexes, which means they are likely to result from exposure to any of the active sonar training activities the U.S. Navy proposed to conduct in the Action Area (see Table 15).

Probable Responses to Active Sonar Exposure There is almost no empirical information available on how humpback whales respond to active sonar exposures. The 68 humpback whales that were observed during monitoring surveys associated with the March 2008 Undersea Warfare Exercises in the Hawaiian Islands reported that none of the marine animals observed from survey vessels or aircraft exhibited unusual behavior or changes in behavior during the surveys.

As discussed in the *Status of the Species* narrative for humpback whales, these whales produce a wide variety of sounds. During the breeding season males sing long, complex songs, with frequencies in the 25-5000 Hz range and intensities as high as 181 dB (Payne 1970, Thompson *et al.* 1986, Winn *et al.* 1970). Source levels average 155 dB and range from 144 to 174 dB (Thompson *et al.* 1979). The songs appear to have an effective range of approximately 10 to 20 km. Animals in mating groups produce a variety of sounds (Silber 1986, Tyack 1981; Tyack and Whitehead 1983).

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.* 1986). 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 1970; Winn *et al.* 1970a; Richardson *et al.* 1995)

2. Social sounds in the breeding areas that extend from 50Hz – more than 10 kHz with most energy below 3kHz (Tyack and Whitehead 1983, Richardson *et al.* 1995); and

3 Feeding area vocalizations that are less frequent, but tend to be 20Hz – 2 kHz with estimated sources levels in excess of 175 dB re 1 uPa-m (Thompson *et al.* 1986, Richardson *et al.* 1995). Sounds often associated with possible aggressive behavior by males (Silber 1986,Tyack 1983) 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 1983).

More recently, Au *et al.* (2006) conducted field investigations of humpback whale songs which 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, 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 150dB 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, impulsed blasts and had extensive mechanical injuries in their ears (Ketten *et al.* 1993, 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.

Because the frequency range humpback whales to which are likely to focus attentional resources appears to overlap with the frequency range of mid-frequency active, we assume that in about 4,622 of the instances in which humpback whales are exposed to mid-frequency active sonar during one or more of the proposed exercises might cause these whales to experience acoustic masking, impairment of acoustic communication, behavioural disturbance, and physiological stress responses as a result of their exposure.

The U.S. Navy's exposure models identified 30 instances in which humpback whales might accumulate sufficient energy from active sonar to experience temporary noise-induced losses of hearing sensitivity.

Despite the extensive amount of attention devoted to threshold shifts in the literature and environmental assessments, it is not certain that threshold shifts are as common in free-ranging animals as this level of attention might imply because free-raning 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 move 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 (Mooney *et al*. 2008, 2009).

Regardless, the data on captive animals and the limited information from free-ranging animals suggests that marine mammals would respond to temporary noise-induced hearing losses (also called "temporary threshold shift" or TTS) primarily through changes in their behavior while their ears recover from any temporary impairment (Box P2.2 of Figure 5 illustrates the potential consequences of noise-induced loss in hearing sensitivity). That is, the behavioral responses of humpback whales that we have already presented would include behavioral changes in fin whales that might have experienced temporary noise-induced losses in hearing sensitivity.

Exposure and Probable Responses to Underwater Detonations. The U.S. Navy estimated that about 2 humpback whales might be exposed annually to underwater detonations on the Virginia Capes Range Complex and experience behavioral harassment or noise-induced loss of hearing sensitivity as a result of that exposure. No humpback whales are likely to be exposed to underwater detonations on the Cherry Point or Jacksonville Range Complexes.

As we discussed with fin whales, we would treat these exposure estimates to be minimal estimates because some humpback whales are likely to be exposed to the sound fields produced by underwater detonations at lower received levels; that is, at received levels that would be expected to cause whales to change their behavioral state even if those changes in behavior might not qualify as "take" as that term is defined by the MMPA.

North Atlantic Right Whale. Our analyses led us to the following conclusions about whether or to what degree North Atlantic right whales might be exposed to vessel traffic, underwater detonations, and active sonar transmissions associated with the military readiness activities the U.S. Navy proposes to conduct on the east coast range complexes from June 2011 through June 2012:

Exposure to Vessel Traffic. We did not estimate the number of North Atlantic right whales or other endangered or threatened whales that might be exposed to vessel traffic independent of the number of individuals that might be exposed to active sonar associated with those exercises because the data we would have needed to support those analyses were not available. Because of their seasonal occurrence on the East Coast Range Complexes, North Atlantic right whales are not likely to be exposed to training exercises that occur in the summer months, such as one of the joint multi-strike group exercises; as a result, North Atlantic right whales are more likely to be exposed to vessel traffic associated with unit-level training, which primarily involves single vessels.

Nevertheless, we assumed that any individuals of the endangered or threatened species that were likely to be exposed to active sonar at received levels sufficiently high to bring them close to the bow of Navy vessels moving at speeds would have some risk of being struck by the ship. For the purposes of these analyses, we assumed that a whale that occurred within 560 meters (1,968 feet) of a Navy vessel moving at speeds greater than 14 knots would have some risk of being struck. As a result, we assumed that one North Atlantic right whale would occur close enough to a Navy vessel that is underway to have some risk of being struck by the vessel.

Because of their seasonal migratory pattern, North Atlantic right whales are not likely to be exposed to vessel traffic that occurs on the Virginia Capes, Cherry Point, or Jacksonville Range Complexes during the summer months. During the winter months, when the distribution of North Atlantic right whales might overlap with training activities on these range complexes, the measures the U.S. Navy and the Permits Division propose to employ during transits (for example, cruising at slow, safe speeds within designated critical habitat for right whales, reducing speeds when a whale is sighted, avoiding head-on approaches to whales, and participating in regional information systems on the distribution of right whales) seem likely to insure that Navy personnel detect North Atlantic right whales, which should prevent the whales from being struck by vessels during transit.

Exposure to Mid-frequency Active Sonar. Based on the U.S. Navy's exposure models, each year we would expect about 733 instances in which North Atlantic right whales might be exposed to active sonar associated with the interrelated AFAST training activities and be "taken" as a result of that exposure (see Table 17). All of these exposure events are likely to occur in the Northeast Operating Areas and the Virginia Capes, Cherry Point, and Jacksonville Range Complexes. As a result, North Atlantic right whales are not likely to be exposed to active sonar associated with surface ship mine warfare exercises, RONEX, or Gulf of Mexico exercises, which only occur in the Gulf of Mexico (see Table 15).

Probable Responses to Active Sonar Exposure North Atlantic right whales are not likely to respond to high frequency sound sources associated with the proposed training activities. However, the evidence is equivocal on whether North Atlantic right whales are likely to respond upon being exposed to mid-frequency active sonar or the nature of any responses they might exhibit if they respond at all. The information available on right whales vocalizations suggests that right whales produce moans less than 400 Hz in frequency (Watkins and Schevill 1972; Thompson *et al.* 1979; Spero 1981), However, Nowacek *et al.* (2004) 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. Although the alert stimulus caused whales to immediately cease foraging behavior and swim rapidly to the surface, Nowacek *et al*. (2004) offer no information on whether the whales were probably responding to the low- or mid-frequency components of the signals.

Although North Atlantic right whales appear to be able to hear mid-frequency (1 kHz–10 kHz) sounds, the limited evidence available suggests that sounds in this frequency range appear to lie at the periphery of their hearing range. The tonal vocalizations right whales produce can be divided into simple, low-frequency, stereo-typed calls and more complex, frequency-modulated, higher-frequency calls (Parks and Clark 2007). Most of these sounds range in frequency from 0.02 to 15 kHz, with dominant frequency ranges from 0.02 to less than 2 kHz with some sounds having multiple harmonics (Parks and Tyack 2005). Assuming that right whales will focus their attentional resources on the frequency ranges of their vocalizations, right whales seem less likely to devote attentional resources to stimuli in the frequency ranges of mid-frequency active sonar. As a result, they are not likely to respond physiologically or behaviorally to sounds in this frequency range.

The U.S. Navy's exposure models identified four instances in which North Atlantic right whales might accumulate sufficient energy from active sonar to experience temporary noise-induced losses of hearing sensitivity. As we have discussed previously, despite the extensive amount of attention devoted to threshold shifts in the literature and environmental assessments, it is not certain that threshold shifts are as common in free-ranging animals as this level of attention might imply because 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 move 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 (Mooney *et al*. 2008, 2009).

Regardless, the data on captive animals and the limited information from free-ranging animals suggests that marine mammals would respond to temporary noise-induced hearing losses (also called "temporary threshold shift" or TTS) primarily through changes in their behavior while their ears recover from any temporary impairment (Box P2.2 of Figure 5 illustrates the potential consequences of noise-induced loss in hearing sensitivity). That is, the behavioral responses of North Atlantic right whales that we have already presented would include behavioral changes in North Atlantic right whales that might have experienced temporary noise-induced losses in hearing sensitivity.

Exposure and Probable Responses to Underwater Detonations. North Atlantic right whales would not be exposed to underwater detonations associated with U.S. Navy training activities in the Northeast Operating Areas. Because of their seasonal migratory pattern, North Atlantic right whales are not likely to be exposed to underwater detonations that occur on the Virginia Capes, Cherry Point, or Jacksonville Range Complexes during the summer months. During the winter months, when the distribution of North Atlantic right whales might overlap with underwater detonations, the measures the U.S. Navy and the Permits Division propose to employ to insure that areas are cleared of marine mammals and sea turtles before beginning training activities that would result in underwater detonations (for example, air-to-surface bombing exercises, air-to-surface missile exercises, and mine neutralization training) seem likely to insure that Navy personnel detect North Atlantic right whales, which should prevent the whales from being exposed to the detonations.

Sei Whale. Our analyses led us to the following conclusions about whether or to what degree sei whales might be exposed to vessel traffic, underwater detonations, and active sonar transmissions associated with the military readiness activities the U.S. Navy proposes to conduct on the east coast range complexes from June 2011 through June 2012:

Exposure to Vessel Traffic. Like the three whales we have discussed thus far, we did not estimate the number of sei whales that might be exposed to vessel traffic independent of the number of individuals that might be exposed to active sonar associated with those exercises because the data we would have needed to support those analyses were not available. Nevertheless, using the approach we just described for blue whales (see the preceding narrative) we assumed that two sei whales would occur close enough to a Navy vessel that is underway to have some risk of being struck by the vessel. Nevertheless, the low frequency of collisions between ships and large whales on the East Coast Range Complexes suggests that a collision is not likely to occur each time one of these whales occurs this close to a Navy vessel.

Exposure to Mid-frequency Active Sonar. Based on the U.S. Navy's exposure models, each year we would expect about 1,163 instances in which sei whales might be exposed to active sonar associated with AFAST training activities and be "taken" as a result of that exposure (see Table 17).

Probable Responses to Active Sonar Exposure As discussed in the *Status of the Species* section of these Opinions, 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 (1 kHz–10 kHz) sounds.

The U.S. Navy's exposure models identified two instances in which sei whales might accumulate sufficient energy from active sonar to experience temporary noise-induced losses of hearing sensitivity. As we have discussed previously, despite the extensive amount of attention devoted to threshold shifts in the literature and environmental assessments, it is not certain that threshold shifts are as common in free-ranging animals as this level of attention might imply because 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 move 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 (Mooney *et al*. 2008, 2009).

Regardless, the data on captive animals and the limited information from free-ranging animals suggests that marine mammals would respond to temporary noise-induced hearing losses (also called "temporary threshold shift" or TTS) primarily through changes in their behavior while their ears recover from any temporary impairment (Box P2.2 of Figure 5 illustrates the potential consequences of noise-induced loss in hearing sensitivity). That is, the behavioral responses of sei whales that we have already presented would include behavioral changes in sei whales that might have experienced temporary noise-induced losses in hearing sensitivity.

Exposure and Probable Responses to Underwater Detonations. Because of their pelagic distribution and low densities in the range complex, the U.S. Navy concluded that no sei whales are likely to be exposed to underwater detonations on the Virginia Capes Range Complex and experience behavioral harassment or noise-induced loss of hearing sensitivity as a result of that exposure. No sei whales are likely to be exposed to underwater detonations on the Cherry Point or Jacksonville Range Complexes.

Sperm Whale. Our analyses led us to the following conclusions about whether or to what degree sperm whales might be exposed to vessel traffic, underwater detonations, and active sonar transmissions associated with the military readiness activities the U.S. Navy proposes to conduct on the east coast range complexes from June 2011 through June 2012:

Exposure to Vessel Traffic. Like the whales we have discussed thus far, we did not estimate the number of sperm whales that might be exposed to vessel traffic independent of the number of individuals that might be exposed to active sonar associated with those exercises because the data we would have needed to support those analyses were not available. Nevertheless, using the approach we just described for blue whales (see the preceding narrative) we assumed that 60 sperm whales would occur close enough to a Navy vessel that is underway to have some risk of being struck by the vessel. Nevertheless, the low frequency of collisions between ships and large whales on the East Coast Range Complexes suggests that a collision is not likely to occur each time one of these whales occurs this close to a Navy vessels.

Exposure to Mid-Frequency Active Sonar. Based on the U.S. Navy's exposure models, each year we would expect about 10,734 instances in which sperm whales might be exposed to active sonar associated with AFAST training activities and be "taken" as a result of that exposure (see Table 17). Like humpback whales, some of these exposure events are likely to occur in the Northeast Operating Areas and the Virginia Capes, Cherry Point, and Jacksonville Range Complexes, which means they might result from exposure to any of the active sonar training activities the U.S. Navy proposes to conduct in the Action Areas for this consultation (see Table 15).

Probable Responses to Active Sonar Exposure Based on their hearing sensitivities, which overlap the frequency range of mid-frequency active sonar, sonar transmissions might mask environmental cues at the lower range of sperm whale hearing. 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.

Based on the frequencies of their vocalizations, which overlap the frequency range of mid-frequency active sonar, sonar transmissions might temporarily reduce the active space of sperm whale vocalizations. Most of the energy of sperm whales clicks is concentrated at 2 to 4 kHz and 10 to 16 kHz, which overlaps with the mid-frequency sonar. Other studies indicate sperm whales' wide-band clicks contain energy between 0.1 and 20 kHz (Weilgart and Whitehead 1993, Goold and Jones 1995). Ridgway and Carder (2001) measured low-frequency, high amplitude clicks with peak frequencies at 500 Hz to 3 kHz from a neonate sperm whale.

There is some evidence of disruptions of clicking and behavior from sonars (Goold 1999, Watkins and Scheville 1975, Watkins *et al.* 1985), pingers (Watkins and Scheville 1975), the Heard Island Feasability Test (Bowles *et al.* 1994), 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 Scheville 1975). Goold (1999) reported six sperm whales that were driven through a narrow channel using ship noise, echosounder, and fishfinder emissions from a flotilla of 10 vessels. Watkins and Scheville (1975) 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).

As discussed previously, 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 *et al.* 1985). Captive bottlenose dolphins and a beluga 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 *et al.* 1997, Schlundt *et al.* 2000), and to shorter broadband pulsed signals (Finneran *et al.* 2000, 2002). 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 (Schlundt *et al.* 2000, Finneran *et al.* 2002). 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.* 2000, 2002). Test animals sometimes vocalized after exposure to pulsed, mid-frequency sound from a watergun (Finneran *et al.* 2002). In some instances, animals exhibited aggressive behavior toward the test apparatus (Ridgway *et al.* 1997, Schlundt *et al.* 2000). The relevance of these data to free-ranging odontocetes is uncertain. In the wild, cetaceans some-times 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.* (2000).

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.* (1995) 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 may 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.* (2000) 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. In one DTAG deployment in the northern Gulf of Mexico on July 28, 2001, researchers documented that the tagged whale moved away from an operating seismic vessel once the seismic pulses were received at the tag at roughly 137 dB re 1 Pa (Johnson and Miller 2002). 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.* 1994).

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 Pa 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, 1998, 2000, 2001, 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.

Preliminary data from an experimental study of sperm whale reactions to seismic surveys in the Gulf of Mexico and a study of the movements of sperm whales with satellite-linked tags in relation to seismic surveys show that during two controlled exposure experiments in which sperm whales were exposed to seismic pulses at received levels up to 148 dB re 1 Pa over octave band with most energy, the whales did not avoid the vessel or change their feeding efficiency (National Science Foundation 2003). Although the sample size is small (4 whales in 2 experiments), the results are consistent with those off northern Norway.

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.

The U.S. Navy's exposure models identified 63 instances in which sperm whales might accumulate sufficient energy from active sonar to experience temporary noise-induced losses of hearing sensitivity. As we have discussed previously, despite the extensive amount of attention devoted to threshold shifts in the literature and environmental assessments, it is not certain that threshold shifts are as common in free-ranging animals as this level of attention might imply because free-raning 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 move 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 (Mooney *et al*. 2008, 2009).

Regardless, the data on captive animals and the limited information from free-ranging animals suggests that marine mammals would respond to temporary noise-induced hearing losses (also called "temporary threshold shift" or TTS) primarily through changes in their behavior while their ears recover from any temporary impairment (Box P2.2 of Figure 5 illustrates the potential consequences of noise-induced loss in hearing sensitivity). That is, the behavioral responses of sperm whales that we have already presented would include behavioral changes in sperm whales that might have experienced temporary noise-induced losses in hearing sensitivity.

Exposure and Probable Responses to Underwater Detonations. The U.S. Navy concluded that two sperm whales might be exposed annually to underwater detonations on the Virginia Capes Range Complex (primarily during a firing exercise) and experience behavioral harassment or noise-induced loss of hearing sensitivity as a result of that exposure. No sperm whales are likely to be exposed to underwater detonations on the Cherry Point or Jacksonville Range Complexes.

As with the whale species we discussed earlier, we would treat these exposure estimates to be minimal estimates because some sperm whales are likely to be exposed to the sound fields produced by underwater detonations at lower received levels; that is, at received levels that would be expected to cause whales to change their behavioral state even if those changes in behavior might not qualify as "take" as that term is defined by the MMPA.

Unspecified Hardshell Turtles**.** (Green, Hawksbill, Kemp's ridley, or loggerhead sea turtles). Green, hawksbill and Kemp's ridley sea turtles would be from the North Atlantic populations of these sea turtles species. Loggerhead sea turtles would be from the Northwest Atlantic population of loggerhead sea turtles. Our analyses led us to the following conclusions about whether or to what degree sea turtles might be exposed to vessel traffic, underwater detonations, expended ordnance, and parachutes associated with the military readiness activities the U.S. Navy proposes to conduct on the east coast range complexes from June 2011 through June 2012:

Exposure to Vessel Traffic. Based on knowledge of the sensory biology of sea turtles (Bartol and Musick, 2003; Levenson *et al*., 2004; Ketten and Bartol, 2006; Moein Bartol and Ketten, 2006), they are likely to detect approaching water vessels via auditory or visual cues, however, there is limited information on how sea turtles are likely to respond to vessel approaches. Hazel *et al*. (2007) reported that turtles fled frequently in encounters with a slow-moving (2.2 knots) vessel, but infrequently in encounters with a moderate-moving (5.9 knots) vessel, and only rarely in encounters with a fast-moving (10.3 knots) vessel.

However, they did not determine whether sea turtles reacted to the sound produced tby he vessel, the presence of the vessel itself, or some other cue.

Hazel *et al*. (2007) reported that sea turtles reacted to approaching vessels in a variety of ways. Benthic turtles launched upwards at a shallow angle and began swimming. The majority of the turtles swam away from the vessel while some swam along the vessel's track and some crossed in front of the vessel's track before swimming away. Sea turtle reaction time was greatly dependent on the speed of the vessel; sea turtles were able to react faster to slower moving vessels than to faster moving vessels. All of these responses were short-term responses that did not seem likely to have adverse long-term consequences for the individual sea turtles.

Probable Responses of Sea Turtles to Mid-Frequency Active Sonar. Although endangered and threatened sea turtles are likely to be exposed to mid-frequency active sonar associated with the training activities the U.S. Navy plans to conduct on the east coast range complexes from June 2011 through June 2012, the lmited information available suggests that the auditory capabilities of sea turtles are centered in the low-frequency range (<1 kHz) (Ridgway *et al.* 1969; Lenhardt *et al.* 1983; Bartol *et al.* 1999, Lenhardt 1994, O'Hara and Wilcox 1990). Ridgway *et al*. (1969) studied the auditory evoked potentials of three green sea turtles (in air and through mechanical stimulation of the ear) and concluded that their maximum sensitivity occurred from 300 to 400 Hz with rapid declines for tones at lower and higher frequencies. They reported an upper limit for cochlear potentials without injury of 2000 Hz and a practical limit of about 1000 Hz. This is similar to estimates for loggerhead sea turtles, which had most sensitive hearing between 250 and 1000 Hz, with rapid decline above 1000 Hz (Bartol *et al*. 1999). These hearing sensitivities are similar to the hearing sensitivities reported for two terrestrial species: pond turtles (*Pseudemys scripta*) and wood turtles (*Chrysemys inscuplta*). Pond turtles are reported to have best hearing responsiveness 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 have sensitivities up to about 500 Hz, followed by a rapid decline above 1000 Hz and almost no responses beyond 3000 or 4000 Hz (Peterson 1966). We assume that these sensitivities to sound apply to all four of the hardshell turtles (i.e., the green, hawksbill, Kmp's ridleyand loggerhead sea turtles). Based on this information sea turtles exposed to received levels of active mid-frequency sonar are not likely to hear mid-frequency sounds (sounds between 1 kHz and 10 kHz); therefore, they are not likely to respond physiologically or behaviorally to those received levels.

A study on the effects of airguns on sea turtle behavior also suggests that sea turtles are most likely to respond to low-frequency sounds. McCauley *et al*. (2000) reported that green and loggerhead sea turtles will avoid air-gun arrays at 2 km and at 1 km with received levels of 166 dB re 1 Pa and 175 db re 1 Pa, respectively. The sea turtles responded consistently: above a level of approximately 166 dB re 1 Pa rms the turtles noticeably increased their swimming activity compared to non-airgun operation periods. Above 175 dB re 1 Pa mean squared pressure their behavior became more erratic possibly indicating the turtles were in an agitated state. Because the sonar that would be used during the proposed exercises transmits at frequencies above hearing thresholds for sea turtles, sea 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 “may affect, but is not likely to adversely affect” green, hawksbill, Kemp’s ridley, or loggerhead sea turtles.

Exposure to Underwater Detonations. On the Virginia Capes Range Complex, the U.S. Navy concluded that 289 hardshell sea turtles (280 during bombing exercises and 9 during firing exercises) might be exposed to underwater detonations at 177 dB re μPa2-s, which would elicit behavioral responses that we would classify as harassment (that is, a significant disruption in normal behavior patterns, such as breeding or feeding). Another 11 hardshell sea turtles might be exposed to underwater detonations at 182 dB re μPa2-s (or 23-pounds per square inch-msec, whichever was greater) which would elicit behavioral responses that we would result in a significant disruption in normal behavior patterns, such as breeding or feeding. Finally, 2 hardshell sea turtles might be exposed to underwater detonations at 205 dB re μPa2-s (or 13-pounds per square inch-msec, whichever was greater) which would result in 50 percent of the animals experiencing rupture of their tympanic membrane; that is, that would constitute an injury that correlates with permanent, noise-induced loss of hearing sensitivity.

On the Cherry Point Range Complex, the U.S. Navy concluded that no hardshell sea turtles might be exposed to underwater detonations and experience behavioral harassment, physiological stress responses, or noise-induced hearing loss as a result of that exposure. No sea turtles are likely to be exposed to the training activities the U.S. Navy proposes to conduct in the Northeast Operating Areas.

On the Jacksonville Range Complex, the U.S. Navy concluded that 6 unspecified hardshell sea turtles (green, hawksbill, Kemp’s ridley, or loggerhead sea turtles) might be exposed to underwater detonations (during firing exercises) at 177 dB re μPa2-s, which would be expected to elicit behavioral responses that we would classify as harassment. Another five of these turtles would be exposed at 182 dB re μPa2-s or 23 psi as result of their exposure to missile exercises, which would correspond to the threshold at which we would expect a temporary loss of hearing sensitivity from a single explosion. Another single hardshell sea turtle might be exposed to underwater detonations at 205 dB re μPa2-s (or 13-pounds per square inch-msec, whichever was greater) which would result in 50 percent of the animals experiencing rupture of their tympanic membrane; that is, that would constitute an injury that correlates with permanent, noise-induced loss of hearing sensitivity.

Sea turtles could be adversely affected if the underwater detonations in the Virginia Capes, Cherry Point, or Jacksonville Range Complexes resulted in the death and injury to prey species or destroyed *Sargassum* rafts and debris lines, which provide habitat for juvenile sea turtles.

Sargassum rafts and debris lines, which may serve as habitat for juveniles of several sea turtle species, are easily detected by aerial observers. The protective measures plan includes procedures to avoid these features during site selection. Pre-detonation monitoring would include aerial observations to identify large *Sargassum* rafts and debris lines that could drift into the Safety Range prior to detonation. Finally, a detonation would be postponed if any large *Sargassum* rafts or debris lines were present in the Safety Range. These measures would not only reduce the probability of exposing sea turtles, it would reduce the probability of exposing sea turtles to reductions in the quantity, quality, or availability of prey or cover.

Probable Responses of Sea Turtles to Underwater Detonations. Klima *et. al.* (1988) conducted an experiment in which Kemp's ridley and loggerhead turtles were placed in cages at four distances from a oil platform to be removed with explosives. The cages were submerged to a depth of 15 ft over the 30 ft sea bottom just prior to the simultaneous explosion of four 50.75 lb charges of nitromethane placed inside the platform pilings at a depth of 16 ft below the mudline. Loggerhead and Kemp‘s ridley turtles at 750 ft and 1,200 ft, as well as one loggerhead at 3,000 ft were rendered unconscious. The Kemp‘s ridley turtle closest to the explosion (range of 750 ft) was slightly injured, with an everted cloacal lining; ridleys at ranges of 1,200 ft, 1,800 ft and 3,000 ft were apparently unharmed. All loggerheads displayed abnormal pink coloration caused by dilated blood vessels at the base of the throat and flippers, a condition that persisted for about 3 weeks.

O'Keeffe and Young (1984) analyzed data from three underwater shock tests carried out off Panama City, Florida in 1981. During each test, a charge equivalent of 1,200 lb of TNT was detonated at mid-depth in water about 120 ft deep. At least three turtles were noted in the area following the detonations. One turtle at a range of 500 to 700 ft as killed. A second turtle at a range of 1,200 ft received minor injuries. A third turtle at 2,000 ft was apparently unaffected. At a depth of 60 ft, calculated shock wave pressures are 239, 161, 85, and 47 psi at ranges of 500, 700, 1,200, and 2,000 ft, respectively.

Based on a parametric evaluation of the effects of charge weight and depth using the Goertner (1982) model, Young (1991) concluded that a conservative safe range for non-injury to a small mammal (representative of a dolphin calf) was approximated by R=578w0.28 (*R* is in feet and *w* is in pounds of explosive). O'Keeffe and Young (1984) proposed that a safe range for turtles from an underwater explosion could be expressed by R = 200 w1/3, where R is the safe range in feet and w is the charge weight in pounds. This equation was subsequently modified by Young (1991) based on safe ranges established by the NMFS for platform removal operations using explosives. The revised equation is R = 560 w1/3. Applied to the Klima *et. al.* (1988) observations, this equation predicts a safe range of 3,291 ft, which exceeds the greatest distance at which an effect was observed (turtle unconscious at 3,000 ft). Applied to the O'Keeffe and Young (1984) report, this equation predicts a safe range of 5,951 ft, nearly triple the range from the charge of the uninjured turtle.

The safe ranges calculated previously addressed physical injury to sea turtles but did not identify problems associated with detecting damage to sea turtle auditory systems. These effects include physical changes to the auditory system that permanently or temporarily destroy or alter a turtle's hearing. Sea turtles do not have an auditory meatus or pinna that channels sound to the middle ear, nor do they have a specialized eardrum. Instead, they have a cutaneous layer and underlying subcutaneous fatty layer, that function as a tympanic membrane. The subcutaneous fatty layer receives and transmits sound to the extra-columella, a cartilaginous disk, located at the entrance to the columella, a long, thin bone that extends from the middle ear cavity to the entrance of the inner ear or otic cavity (Ridgway *et al.* 1969). Sound arriving at the inner ear via the columella is transduced by the bones of the middle ear. Sound also arrives by bone conduction through the skull. Low frequency sounds at high source levels can also be detected by vibration-sensitive touch receptors in various other parts of the turtle's body (mechanoreception). Any disruption (permanent or temporary) of a turtle's hearing may kill or injure the turtle. On the other hand, some effects may be temporary or slight and will not have lethal results.

Sea turtle auditory sensitivity has not been well studied. A few preliminary investigations suggest that it is limited to low frequency band-widths, such as the sounds of waves breaking on a beach. The role of underwater low frequency hearing in sea turtles is unclear. It has been suggested that sea turtles may use acoustic signals from their environment as guideposts during migration and as a cue to identify their natal beaches (Moein *et al.* 1983).

Although it is possible that green turtles in the vicinity of an in-water detonation might experience a temporary or permanent threshold shift, it is not known what energy levels and received levels are necessary to induce threshold shifts. The few studies completed on the auditory capabilities of sea turtles (adult green, loggerhead, and Kemp's ridley *(Lepidochelys kempii*) suggest that they could be capable of hearing low frequency sounds (Ridgway *et al.* 1969; Moein *et al.* 1983; Lenhardt,1994). Ridgway *et al.* (1969) reported maximal sensitivity for green turtles occurred at 300 to 400 Hz, with a rapid decline in sensitivity for lower and higher tones. Similarly, Moein *et al.* (1994) reported a hearing range of about 250 to 1,000 Hz for loggerhead sea turtles, and Lenhardt (1994) stated that maximal sensitivity in sea turtles generally occurs in the range from 100 to 800 Hz. Calculated in-water hearing thresholds within the useful range appear to be high (e.g., about 160 to 200 dB re 1 μPa; Lenhardt, 1994). In the absence of more specific information that could be used to determine the acoustic harassment range for sea turtles, the U.S. Navy assumed that frequencies >100 Hz (which are the acoustical harassment ranges predicted for odontocetes) would be conservative for sea turtles.

Exposure to Expended Ordnance. The U.S. Navy argued that endangered and threatened species might be exposed to expended ordnance and other materials only if they ingested those materials (U.S. Navy 2009b). Endangered and threatened sea turtles in the Action Areas for this consultation are likely to be exposed to expended material through ingestion and physical encounter. Sea turtles of all sizes and species are known to ingest a wide variety of marine debris, including plastic bags, plastic sheeting, balloons, Styrofoam beads, monofilament fishing line, and tar are also known to be ingested (NRC 1990, Lutz 1990, Bjorndal 1994). Although marine debris has been reported to have killed sea turtles, they are more commonly reported to impair or disable sea turtles sublethally without killing them (NRC 1990, Bjorndal 1994).

Ordnance-related material would settle to the sea floor where it could be available for ingestion by benthic foraging sea turtles. The probability of sea turtles ingesting this material would depend on factors such as the size of the material, the likelihood the material would be mistaken for prey, and the level benthic foraging that occurs in the impact area (which is a function of benthic habitat quality), prey availability, and species specific foraging strategies.

Most of the ordnance fired in the Virginia Capes Range Complex would be conducted more than 12 nm offshore where sea turtles are less likely to engage in foraging behavior (a majority of benthic foraging by green, hawksbill, Kemp's ridley, and loggerhead turtles occurs in nearshore areas (Lutcavage *et al.*

1997)). However, water depths in Cherry Point and the Jacksonville Range Complexes ranges from about 20 m to greater than 200 m at distances greater than 3 nm from shore. As a result, green, hawksbill, Kemp's ridley, and loggerhead sea turtles might be exposed to expended ordnance on the Cherry Point and Jacksonsville Range Complexes. Leatherback sea turtles are less likely to be exposed to expended materials in any of these ranges because they are not benthic feeders.

Kemp's ridley Sea Turtle. Our analyses led us to the following conclusions about whether or to what degree Kemp's ridley sea turtles might be exposed to underwater detonations, expended ordnance, and parachutes associated with the military readiness activities the U.S. Navy proposes to conduct on the east coast range complexes from June 2011 through June 2012:

Exposure to Vessel Traffic. Based on knowledge of the sensory biology of sea turtles (Bartol and Musick, 2003; Levenson *et al*., 2004; Ketten and Bartol, 2006; Moein Bartol and Ketten, 2006), they are likely to detect approaching water vessels via auditory or visual cues, however, there is limited information on how sea turtles are likely to respond to vessel approaches. Hazel *et al*. (2007) reported that turtles fled frequently in encounters with a slow-moving (2.2 knots) vessel, but infrequently in encounters with a moderate-moving (5.9 knots) vessel, and only rarely in encounters with a fast-moving (10.3 knots) vessel. However, they did not determine whether sea turtles reacted to the sound produced the vessel, the presence of the vessel itself, or some other cue.

Hazel *et al*. (2007) reported that sea turtles reacted to approaching vessels in a variety of ways. Benthic turtles launched upwards at a shallow angle and began swimming. The majority of the turtles swam away from the vessel while some swam along the vessel's track and some crossed in front of the vessel's track before swimming away. Sea turtle reaction time was greatly dependent on the speed of the vessel; sea turtles were able to react faster to slower moving vessels than to faster moving vessels. All of these responses were short-term responses that did not seem likely to have adverse long-term consequences for the individual sea turtles.

Exposure to Underwater Detonations. The U.S. Navy estimated that 540 Kemp's ridley sea turtles might be exposed to underwater detonations on the Virginia Capes Range Complex (526 during bombing exercises and 14 during firing exercises) at 177 dB re μPa2-s, which would be expected to elicit behavioral responses that we would classify as harassment. During bombing and firing exercises, 15 Kemp's ridley sea turtles, respectively would be exposed at 182 dB re μPa2-s or 23 pounds per square inch-msec (psi), whichever encompasses the largest geographic range, which corresponds to the threshold at which we would expect a temporary loss of hearing sensitivity from a single explosion. Five Kemp's ridley sea turtles might be exposed during bombing and firing exercises to underwater detonations at 205 dB re μPa2-s or 13 pounds psi, which corresponds to an exposure in which 50 percent of the animals would be expected to experience rupture of their tympanic membrane, an injury that correlates with measures of permanent hearing impairment (specifically, a 30 percent incidence of permanent loss of hearing sensitivity or PTS; Ketten 1998).

On the Cherry Point Range Complex, the U.S. Navy concluded that no Kemp's ridley sea turtles might be exposed to underwater detonations and experience behavioral harassment, physiological stress responses, or noise-induced hearing loss as a result of that exposure.

The U.S. Navy estimated that one Kemp's ridley sea turtle might be exposed to underwater detonations on the Jacksonville Range Complex (during firing exercises) at 177 dB re μPa2-s, which would be expected to elicit behavioral responses that we would classify as harassment. During missile exercises, another Kemp's ridley sea turtle would be exposed at 182 dB re μPa2-s or 23 psi, which corresponds to the threshold at which we would expect a temporary loss of hearing sensitivity from a single explosion. No Kemp's ridley sea turtles would be exposed at 205 dB re μPa2-s or 13 pounds psi as a result of exercises on the Jacksonville Range Complex.

If they are exposed to underwater detonations, we would expect Kemp's ridley sea turtles to exhibit the responses we discussed under unspecified hard-shelled sea turtles.

Exposure to ParachutesReleased During Deployment of Sonobuoys. When AN/SQS-62 DICASS and other sonobuoys impact the water surface after being deployed from aircraft, their parachute assemblies of sonobuoys deployed by aircraft are jettisoned and sink away from the sonobuoy, while a float containing an antenna is inflated. The parachutes are made of nylon and are about 8 feet in diameter. At maximum inflation, the canopies are between 0.15 to 0.35 square meters (1.6 to 3.8 squared feet). The shroud lines range from 0.30 to 0.53 meters (12 to 21 inches) in length and are made of either cotton polyester with a 13.6 kilogram (30 pound) breaking strength or nylon with a 45.4 kilogram (100 pound) breaking strength. All parachutes are weighted with a 0.06 kilogram (2 ounce) steel material weight, which would cause the parachute to sink from the surface within about 15 minutes, although actual sinking rates depend on ocean conditions and the shape of the parachute.

The subsurface assembly descends to a selected depth, and the sonobuoy case falls away and sea anchors deploy to stabilize the hydrophone (underwater microphone). The operating life of the seawater battery is eight hours, after which the sonobuoy scuttles itself and sinks to the ocean bottom. For the sonobouys, concentrations of metals released from batteries were calculated to be 0.0011 mg/L lead, 0.000015mg/L copper, and 0.0000001mg/L silver.

Sea turtles that occur on the East Coast Range Complexes might encounter one or more of the parachutes after they have been jettisoned from these sonobuoys and could become entangled as a result. Whales also might encounter one or more of these parachutes and become entangled as it sinks to the bottom or once it is on the seafloor. We cannot, however, determine whether such interactions are probable, given the relatively small number of sonobuoys that would be employed in each of the exercises, the relatively large geographic area involved, and the relatively low densities of endangered or threatened marine mammals and sea turtles on the range complex.

Leatherback Sea Turtle. Our analyses led us to the following conclusions about whether or to what degree leatherback sea turtles might be exposed to underwater detonations, expended ordnance, and parachutes associated with the military readiness activities the U.S. Navy proposes to conduct on the east coast range complexes from June 2011 through June 2012:

Exposure to Vessel Traffic. Based on knowledge of the sensory biology of sea turtles (Bartol and Musick, 2003; Levenson *et al*., 2004; Ketten and Bartol, 2006; Moein Bartol and Ketten, 2006), they are likely to detect approaching water vessels via auditory or visual cues, however, there is limited information on how sea turtles are likely to respond to vessel approaches. Hazel *et al*. (2007) reported that turtles fled frequently in encounters with a slow-moving (2.2 knots) vessel, but infrequently in encounters with a moderate-moving (5.9 knots) vessel, and only rarely in encounters with a fast-moving (10.3 knots) vessel. However, they did not determine whether sea turtles reacted to the sound produced the vessel, the presence of the vessel itself, or some other cue.

Hazel *et al*. (2007) reported that sea turtles reacted to approaching vessels in a variety of ways. Benthic turtles launched upwards at a shallow angle and began swimming. The majority of the turtles swam away from the vessel while some swam along the vessel's track and some crossed in front of the vessel's track before swimming away. Sea turtle reaction time was greatly dependent on the speed of the vessel; sea turtles were able to react faster to slower moving vessels than to faster moving vessels. All of these responses were short-term responses that did not seem likely to have adverse long-term consequences for the individual sea turtles.

Exposure to Underwater Detonations. On the Virginia Capes Range Complex, the U.S. Navy estimated that nine leatherback sea turtles might be exposed to underwater detonations (during bombing exercises) at 177 dB re μPa2-s, which would be expected to elicit behavioral responses that we would classify as harassment. No leatherback sea turtles were expected to be exposed at 182 dB re μPa2-s, 23 psi, 205 dB re μPa2-s or 13 pounds psi, which corresponds to the threshold at which we would expect a temporary loss of hearing sensitivity from a single explosion. Further, no leatherback sea turtles were expected to be exposed at 205 dB re μPa2-s or 13 pounds psi which corresponds to an exposure in which 50 percent of the animals would be expected to experience rupture of their tympanic membrane, an injury that correlates with measures of permanent hearing impairment (specifically, a 30 percent incidence of permanent loss of hearing sensitivity or PTS; Ketten 1998).

On the Cherry Point Range Complex, the U.S. Navy concluded that no leatherback sea turtles might be exposed to underwater detonations and experience behavioral harassment, physiological stress responses, or noise-induced hearing loss as a result of that exposure. No leatherback sea turtles are likely to be exposed to the training activities the U.S. Navy proposes to conduct in the Northeast Operating Areas.

On the Jacksonville Range Complex, the U.S. Navy estimated that eight leatherback sea turtles might be exposed to underwater detonations (during firing exercises) at 177 dB re μPa2-s, which would be expected to elicit behavioral responses that we would classify as harassment. Three leatherback sea turtles would be expected to be exposed (during missile exercises) at 182 dB re μPa2-s, 23 psi, 205 dB re μPa2-s or 13 pounds psi, which corresponds to the threshold at which we would expect a temporary loss of hearing sensitivity from a single explosion. Further, one leatherback sea turtle would be expected to be exposed (during firing exercises) at 205 dB re μPa2-s or 13 pounds psi which corresponds to an exposure in which 50 percent of the animals would be expected to experience rupture of their tympanic membrane, an injury that correlates with measures of permanent hearing impairment (specifically, a 30 percent incidence of permanent loss of hearing sensitivity or PTS; Ketten 1998).

Exposure to Parachutes. When AN/SQS-62 DICASS and other sonobuoys impact the water surface after being deployed from aircraft, their parachute assemblies of sonobuoys deployed by aircraft are jettisoned and sink away from the sonobuoy, while a float containing an antenna is inflated. The parachutes are made of nylon and are about 8 feet in diameter. At maximum inflation, the canopies are between 0.15 to 0.35 square meters (1.6 to 3.8 squared feet). The shroud lines range from 0.30 to 0.53 meters (12 to 21 inches) in length and are made of either cotton polyester with a 13.6 kilogram (30 pound) breaking strength or nylon with a 45.4 kilogram (100 pound) breaking strength. All parachutes are weighted with a 0.06 kilogram (2 ounce) steel material weight, which would cause the parachute to sink from the surface within about 15 minutes, although actual sinking rates depend on ocean conditions and the shape of the parachute.

The subsurface assembly descends to a selected depth, and the sonobuoy case falls away and sea anchors deploy to stabilize the hydrophone (underwater microphone). The operating life of the seawater battery is eight hours, after which the sonobuoy scuttles itself and sinks to the ocean bottom. For the sonobouys, concentrations of metals released from batteries were calculated to be 0.0011 mg/L lead, 0.000015mg/L copper, and 0.0000001mg/L silver.

Sea turtles that occur on the East Coast Range Complexes might encounter one or more of the parachutes after they have been jettisoned from these sonobuoys and could become entangled as a result. Whales also might encounter one or more of these parachutes and become entangled as it sinks to the bottom or once it is on the seafloor. We cannot, however, determine whether such interactions are probable, given the relatively small number of sonobuoys that would be employed in each of the exercises, the relatively large geographic area involved, and the relatively low densities of endangered or threatened marine mammals and sea turtles on the range complex.

Loggerhead sea turtle. Our analyses led us to the following conclusions about whether or to what degree loggerhead sea turtles might be exposed to vessel traffic, underwater detonations, expended ordnance, and parachutes associated with the military readiness activities the U.S. Navy proposes to conduct on the east coast range complexes from June 2010 through June 2011:

Exposure to Vessel Traffic. Based on knowledge of the sensory biology of sea turtles (Bartol and Musick, 2003; Levenson *et al*., 2004; Ketten and Bartol, 2006; Moein Bartol and Ketten, 2006), they are likely to detect approaching water vessels via auditory or visual cues, however, there is limited information on how sea turtles are likely to respond to vessel approaches. Hazel *et al*. (2007) reported that turtles fled frequently in encounters with a slow-moving (2.2 knots) vessel, but infrequently in encounters with a moderate-moving (5.9 knots) vessel, and only rarely in encounters with a fast-moving (10.3 knots) vessel.

However, they did not determine whether sea turtles reacted to the sound produced the vessel, the presence of the vessel itself, or some other cue.

Hazel *et al*. (2007) reported that sea turtles reacted to approaching vessels in a variety of ways. Benthic turtles launched upwards at a shallow angle and began swimming. The majority of the turtles swam away from the vessel while some swam along the vessel's track and some crossed in front of the vessel's track before swimming away. Sea turtle reaction time was greatly dependent on the speed of the vessel; sea turtles were able to react faster to slower moving vessels than to faster moving vessels. All of these responses were short-term responses that did not seem likely to have adverse long-term consequences for the individual sea turtles.

Exposure to Underwater Detonations. On the Virginia Capes Range Complex, the U.S. Navy estimated that 429 loggerhead sea turtles might be exposed to underwater detonations on the Virginia Capes Range Complex (415 during bombing exercises and 14 during firing exercises) at 177 dB re μPa2-s, which would be expected to elicit behavioral responses that we would classify as harassment. During missile and mining exercises, 16 and 21 (respectively) loggerhead sea turtles would be exposed at 182 dB re μPa2-s or 23 pounds per square inch-msec (psi), which corresponds to the threshold at which we would expect a temporary loss of hearing sensitivity from a single explosion. Eight loggerhead sea turtles (four during MINEX, 3 during bombing and 1 during firing exercises) might be exposed to underwater detonations and experience noise-induced hearing loss as a result of their exposure. at 205 dB re μPa2-s or 13 pounds psi, which corresponds to an exposure in which 50 percent of the animals would be expected to experience rupture of their tympanic membrane, an injury that correlates with measures of permanent hearing impairment (specifically, a 30 percent incidence of permanent loss of hearing sensitivity or PTS; Ketten 1998).

On the Jacksonville Range Complex, the U.S. Navy estimated that 10 loggerhead sea turtles might be exposed to underwater detonations during firing exercises at 177 dB re μPa2-s, which would be expected to elicit behavioral responses that we would classify as harassment. During missile exercises, 7 loggerhead sea turtles would be exposed at 182 dB re μPa2-s or 23 pounds per square inch-msec (psi), which corresponds to the threshold at which we would expect a temporary loss of hearing sensitivity from a single explosion. Another single loggerhead sea turtles would be expected to be exposed during firing excises to 205 dB re μPa2-s or 13 pounds psi as a result of exercises on the Jacksonville Range Complex.

Sea turtles could be adversely affected if the underwater detonations in the Virginia Capes, Cherry Point, or Jacksonville Range Complexes resulted in the death and injury to prey species or destroyed *Sargassum* rafts and debris lines, which provide habitat for juvenile sea turtles.

Sargassum rafts and debris lines, which may serve as habitat for juveniles of several sea turtle species, are easily detected by aerial observers. The protective measures plan includes procedures to avoid these features during site selection. Pre-detonation monitoring would include aerial observations to identify large *Sargassum* rafts and debris lines that could drift into the Safety Range prior to detonation. Finally, a detonation would be postponed if any large *Sargassum* rafts or debris lines were present in the Safety

Range. These measures would not only reduce the probability of exposing sea turtles, it would reduce the probability of exposing sea turtles to reductions in the quantity, quality, or availability of prey or cover.

If they are exposed to underwater detonations, we would expect loggerhead sea turtles to exhibit the responses we discussed under unspecified hard-shelled sea turtles.

Exposure to Parachutes. When AN/SQS-62 DICASS and other sonobuoys impact the water surface after being deployed from aircraft, their parachute assemblies of sonobuoys deployed by aircraft are jettisoned and sink away from the sonobuoy, while a float containing an antenna is inflated. The parachutes are made of nylon and are about 8 feet in diameter. At maximum inflation, the canopies are between 0.15 to 0.35 square meters (1.6 to 3.8 squared feet). The shroud lines range from 0.30 to 0.53 meters (12 to 21 inches) in length and are made of either cotton polyester with a 13.6 kilogram (30 pound) breaking strength or nylon with a 45.4 kilogram (100 pound) breaking strength. All parachutes are weighted with a 0.06 kilogram (2 ounce) steel material weight, which would cause the parachute to sink from the surface within about 15 minutes, although actual sinking rates depend on ocean conditions and the shape of the parachute.

The subsurface assembly descends to a selected depth, and the sonobuoy case falls away and sea anchors deploy to stabilize the hydrophone (underwater microphone). The operating life of the seawater battery is eight hours, after which the sonobuoy scuttles itself and sinks to the ocean bottom. For the sonobouys, concentrations of metals released from batteries were calculated to be 0.0011 mg/L lead, 0.000015mg/L copper, and 0.0000001mg/L silver.

Sea turtles that occur on the East Coast Range Complexes might encounter one or more of the parachutes after they have been jettisoned from these sonobuoys and could become entangled as a result. Whales also might encounter one or more of these parachutes and become entangled as it sinks to the bottom or once it is on the seafloor. We cannot, however, determine whether such interactions are probable, given the relatively small number of sonobuoys that would be employed in each of the exercises, the relatively large geographic area involved, and the relatively low densities of endangered or threatened marine mammals and sea turtles on the range complex.

CRITICAL HABITAT FOR NORTH ATLANTIC RIGHT WHALES. The only kind of exercise the U.S. Navy plans to conduct inside the critical habitat that has been designated for North Atlantic right whales off the southeast coast of the United States and Associated Area of Concern (the area extending 5 nm seaward of the boundaries of the critical habitat designation) during the calving season for right whale would be precision anchorage drills, swept channel exercises, maritime security operations and possibly the employment of the Shipboard Electronic System Evaluation Facility range with clearance and advice from Fleet Area Control and Surveillance Facility-Jacksonville. These activities are not likely to reduce the number of North Atlantic right whales that might occur in designated critical habitat or affect the quantity, quality, or availability of the area that has been designated as critical habitat for those North Atlantic right whales that occur in the designated critical habitat.

U.S. Navy requires vessels to avoid transiting through the area that has been designated as critical habitat for North Atlantic right whales when right whales are likely to occur in those areas (see Table 16) and, if vessels must transit through those areas, to first comply with measures that make U.S. Navy personnel aware of the number and distribution of right whales and increase their probability of detecting those right whales. Further, the U.S. Navy does not propose to conduct training activities involving underwater detonations or high explosive charges within the boundaries of critical habitat that has been designated for North Atlantic right whales. As a result, the vessel traffic and underwater detonations are not likely to reduce the number of North Atlantic right whales that might occur in designated critical habitat or affect the quantity, quality, or availability of the area that has been designated as critical habitat for those North Atlantic right whales that occur in the designated critical habitat.

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 these Opinions. 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 foreseeable future.

Integration and Synthesis of Effects

In the *Assessment Approach* section of these Opinions, we stated that we measure risks to individuals of endangered or threatened species using changes in the individual's "fitness" or the individual's growth, survival, annual reproductive success, and lifetime reproductive success. When we do not expect listed plants or 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 2000, Mills and Beatty 1979, Brandon 1978, Stearns 1977, 1992). As a result, if we conclude that listed species are *not* likely to experience reductions in their fitness, we would conclude our assessment. If, however, we conclude that listed species are likely to experience reductions in their fitness, we assess the potential effects of the action on the viability of the population or populations' those individuals represent. At the population level, we would generally assume that an action that increased a population's probability of becoming extinct would place an endangered or threatened species at greater risk of extinction because species become extinct as a result of the extinction of the populations that comprise them.

The following discussions separately summarize the probable risks future training exercises on the Northeast Operating Areas, Virginia Capes Range Complex, Cherry Point Range Complex, and Jacksonville Range Complex pose to threatened and endangered species that are likely to be exposed to those transmissions. These summaries integrate the exposure profiles presented previously with the results of our response analyses for each of the actions considered in these Opinions.

Probable Consequences of Exposing Listed Species to the Proposed Actions

Thus far, the narratives have identified the probable number of times endangered or threatened species might be exposed to stressors associated with the proposed action (primarily underwater detonations) and stressors associated with the Atlantic Fleet Active Sonar Training, which is interrelated to the proposed action. Those narratives have also identified the probable responses of those species to those exposures (for example, noise-induced loss of hearing sensitivity). The narratives that follow discuss the probable consequences; the consequences of exposures to active sonar re-summarizes the analyses we presented in our January 2009 and subsequent Opinions on the U.S. Navy's Atlantic Fleet Active Sonar Training and the Permits Division's proposal to authorize the "take" of marine mammals associated with that training.

BLUE WHALES. Blue whales would not be exposed to underwater detonations associated with U.S. Navy training activities in the Northeast Operating Areas or the Virginia Capes, Cherry Point, or Jacksonville Range Complexes. Based on the U.S. Navy's exposure models, each year we would expect about 881 instances in which blue whales might be exposed to active sonar associated with AFAST training activities and be "taken" as a result of that exposure (see Table 17). All of these exposure events are likely to occur in the Northeast Operating Area, which means they are likely to result from exposure to active sonar associated with submarines and maritime patrol aircraft.

As discussed in the introduction to the *Approach to the Assessment* and *Exposure Analyses* sections of these Opinions, these estimates probably over-estimate the actual number of blue whales that are likely to be exposed to one or more of the active sonar training activities the U.S. Navy plans to conduct in the Northeast Operating Areas. Most marine mammals would only be exposed periodically or episodically, if at all, to those activities and many exercises would 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.

Blue whales are not likely to respond to high-frequency sound sources associated with the proposed training activities. Blue whales appear to be able to hear mid-frequency (1 kHz–10 kHz) sounds, sounds in this frequency range lie at the periphery of their hearing range and they are less likely to devote attentional resources to stimuli in this frequency range. Blue whales vocalizations include a variety of sounds described as low frequency moans or long pulses in the 10-100 Hz band (Cummings and Thompson 1971; Edds 1982; Thompson and Friedl 1982; McDonald *et al.* 1995; Clark and Fristrup 1997; Rivers 1997). The most typical signals are very long, patterned sequences of tonal infrasonic sounds in the 15-40 Hz range. Ketten (1997) 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. Blue 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 1971). The whale produced a short, 390 Hz pulse during the moan. Based on this information blue whales exposed to received levels of active mid-frequency sonar are not likely to respond physiologically or behaviorally to sounds in this frequency range.

Blue whales in the action area seem likely to respond to the ship traffic associated with each of the active sonar training activities the U.S. Navy plans to conduct along the Atlantic Coast and in the Gulf of Mexico in ways that approximate their responses to whale watch vessels. As discussed in the *Environmental Baseline* section of these Opinions, 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. 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 exercise 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. However, blue whales are not likely to respond to mid-frequency active sonar because they are not likely to hear those sonar transmissions.

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 interactions (Amaral and Carlson 2005; Au and Green 2000, Cockeron 1995, Erbe 2002, Félix 2001, Magalhães *et al.* 2002, Richter *et al.* 2003, Scheidat *et al.* 2004, Simmonds 2005, Watkins 1986, Williams *et al.* 2002). 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 exercises, 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 blue whales to reduce the fitness of the blue whales that occur along the Atlantic Coast.

Based on the evidence available, we conclude that the training activities the U.S. Navy plans to conduct on the Northeast Operating Areas and the Virginia Capes, Cherry Point, and Jacksonville Range Complexes from June 2011 to June 2012 and the active sonar training they plan to conduct along the Atlantic Coast 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. As we discussed in the *Approach to the Assessment* section of these Opinions, 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). As a result, we conclude that the mine warfare, surface warfare, small arms training, air warfare, amphibious warfare, electronic combat operations, and test and evaluations ordnance training activities the U.S. Navy plans to conduct along the Atlantic Coast from June 2011 to June 20121 and the active sonar training activities the Navy conducts along the Atlantic Coast each year would not appreciably reduce the blue whales’ likelihood of surviving and recovering in the wild.

FIN WHALES. Fin whales would not be exposed to underwater detonations associated with U.S. Navy training activities in the Northeast Operating Areas, Cherry Point Range Complex, or Jacksonville Range Complex. However, the U.S. Navy estimated that about 2 fin whales might be exposed to underwater detonations on the Virginia Capes Range Complex and experience behavioral harassment or noise-induced loss of hearing sensitivity as a result of that exposure.

Based on the U.S. Navy’s exposure models, each year we would expect about 970 instances in which fin whales might be exposed to active sonar associated with AFAST training activities and be “taken" as a result of that exposure. Like blue whales, all of these exposure events are likely to occur in the Northeast Operating Area, which means they are likely to result from exposure to active sonar associated with submarines and maritime patrol aircraft. As with blue whales, these estimates probably over-estimate the actual number of fin whales that might be exposed to active sonar training activities the U.S. Navy conducts along the Atlantic Coast. Most fin whales would only be exposed periodically or episodically, if at all, to the active sonar training activities the U.S. Navy conducts along the Atlantic coast and many exercises would 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.

As discussed in the *Status of the Species* section of these Opinions, fin whales produce a variety of low-frequency sounds in the 10-200 Hz band (Watkins 1981; Watkins *et al.* 1987a; Edds 1988; Thompson *et al.* 1992). The most typical signals are long, patterned sequences of short duration (0.5-2s) infrasonic pulses in the 18-35 Hz range (Patterson and Hamilton 1964). Estimated source levels are as high as 190 dB (Patterson and Hamilton 1964; Watkins *et al.* 1987a; Thompson *et al.* 1992; McDonald *et al.* 1995). 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 (Clark and Charif 1998). Short sequences of rapid pulses in the 20-70 Hz band are associated with animals in social groups (McDonald *et al.* 1995). Each pulse lasts on the order of one second and contains twenty cycles (Tyack 1999). This information would lead us to conclude that fin whales exposed to these received levels of active mid-frequency sonar are not likely to respond physiologically or behaviorally.

Fin whales in the action area seem likely to respond to the ship traffic associated with active sonar training activities the U.S. Navy conducts along the Atlantic Coast in ways that approximate their responses to whale watch vessels. As discussed in the *Environmental Baseline* section of these Opinions, 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. 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 exercise 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 whales might not respond to the vessels, while in other circumstances, fin whales are likely to change their vocalizations, surface time, swimming speed, swimming angle or direction, respiration rates, dive times, feeding behavior, and social interactions (Amaral and Carlson 2005; Au and Green 2000, Cockeron 1995, Erbe 2002, Félix 2001, Magalhães *et al.* 2002, Richter *et al.* 2003, Scheidat *et al.* 2004, Simmonds 2005, Watkins 1986, Williams *et al.* 2002). 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 different exercises and the small number of times the exercises are likely to be repeated, we do not expect these responses of fin whales to reduce the fitness of the fin whales that occur along the Atlantic Coast of the United States.

Based on the evidence available, we conclude that the training activities the U.S. Navy plans to conduct on the Northeast Operating Areas and the Virginia Capes, Cherry Point, and Jacksonville Range Complexes from June 2011 to June 2012 and the active sonar training they plan to conduct along the Atlantic Coast are not likely to adversely affect the population dynamics, behavioral ecology, and social dynamics of individual fin whales in ways or to a degree that would reduce their fitness. As we discussed in the *Approach to the Assessment* section of these Opinions, 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). As a result, we conclude that the mine warfare, surface warfare, small arms training, air warfare, amphibious warfare, electronic combat operations, and test and evaluations ordnance training activities the U.S. Navy plans to conduct along the Atlantic Coast from June 2011 to June 2012 and the active sonar training activities the Navy conducts along the Atlantic Coast each year would not appreciably reduce the fin whale's likelihood of surviving and recovering in the wild.

HUMPBACK WHALES. Humpback whales would not be exposed to underwater detonations associated with U.S. Navy training activities in the Northeast Operating Areas. However, the U.S. Navy estimated that about 2 humpback whales might be exposed to underwater detonations on the Virginia Capes Range Complex and experience behavioral harassment or noise-induced loss of hearing sensitivity as a result of that exposure.

These exposures would be in addition to the 4,622 instances in which humpback whales might be exposed to active sonar associated with AFAST training activities and be "taken" as a result of that exposure. Unlike blue and fin whales, some of these exposure events are likely to occur during any of the active sonar training activities the U.S. Navy may conduct each year in the AFAST Operating Areas along the Atlantic east coast and the Gulf of Mexico.

Humpback whales produce a wide variety of sounds. During the breeding season males sing long, complex songs, with frequencies in the 25-5000 Hz range and intensities as high as 181 dB (Payne 1970; Winn *et al.* 1970a; Thompson *et al.* 1986). Source levels average 155 dB and range from 144 to 174 dB (Thompson *et al.* 1979). The songs appear to have an effective range of approximately 10 to 20 km. Animals in mating groups produce a variety of sounds (Tyack 1981; Tyack and Whitehead 1983, Silber 1986).

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 sec and source levels of 175-192 dB (Thompson *et al.* 1986). 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 1970; Winn *et al.* 1970a; Richardson *et al.* 1995)

2. Social sounds in the breeding areas that extend from 50Hz – more than 10 kHz with most energy below 3kHz (Tyack and Whitehead 1983, Richardson *et al.* 1995); and

3. Feeding area vocalizations that are less frequent, but tend to be 20Hz – 2 kHz with estimated sources levels in excess of 175 dB re 1 uPa-m (Thompson *et al.* 1986; Richardson *et al.* 1995).

> Sounds often associated with possible aggressive behavior by males (Tyack 1983; Silber 1986) 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 1983).

More recently, Au *et al.* (2006) 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 proposed active sonar training activities 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, 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 conspecific calls 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 150dB 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, impulsed blasts and had extensive mechanical injuries in their ears (Ketten *et al.* 1993; 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.

Because their hearing range appears to overlap with the frequency range of mid-frequency active, we assume that some of the humpback whales that are exposed to mid-frequency active sonar during one or more of the proposed exercises might experience acoustic masking, impairment of acoustic communication, behavioural disturbance, and physiological stress responses as a result of their exposure.

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 areas 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 because the Action Area represents only a small portion of their feeding range. As a result, we do not expect these disruptions to reduce the fitness (reproductive success or longevity) of any individual animal or to result in physiological stress responses that rise to the level of distress.

The strongest evidence that of the probable impact of the *Environmental Baseline* on humpback whales consists of the estimated growth rate of the humpback whale population in the Atlantic Ocean. Despite small numbers that are entangled in fishing gear in the action area, this increase in the number of humpback whales suggests that the stress regime these whales are exposed to in the Atlantic Ocean have not prevented these whales from increasing their numbers in the action area. As discussed in the *Environmental Baseline* section of these Opinions, humpback whales have been exposed to active sonar training activities along the Atlantic Coast of the United States and in the Gulf of Mexico, 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 in the North Atlantic Ocean would be higher absent their exposure to these activities, the rate at which humpback whales occur in the Gulf of Maine 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 in the North Atlantic Ocean are increasing.

Based on the evidence available, we conclude that the training activities the U.S. Navy plans to conduct on the Northeast Operating Areas and the Virginia Capes, Cherry Point, and Jacksonville Range Complexes from June 2011 to June 2012 and the active sonar training they plan to conduct along the Atlantic Coast are not likely to adversely affect the population dynamics, behavioral ecology, and social dynamics of individual humpback whales in ways or to a degree that would reduce their fitness. As we discussed in the *Approach to the Assessment* section of these Opinions, 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). As a result, we conclude that the mine warfare, surface warfare, small arms training, air warfare, amphibious warfare, electronic combat operations, and test and evaluations ordnance training activities the U.S. Navy plans to conduct along the Atlantic Coast from June 2011 to June 2012 and the active sonar training activities the Navy conducts along the Atlantic Coast each year would not appreciably reduce the humpback whale's likelihood of surviving and recovering in the wild.

NORTH ATLANTIC RIGHT WHALES. North Atlantic right whales would not be exposed to underwater detonations associated with U.S. Navy training activities in the Northeast Operating Areas or the Virginia Capes, Cherry Point, or Jacksonville Range Complexes. However, each year we would expect about 733 instances in which North Atlantic right whales might be exposed to active sonar associated with the interrelated AFAST training activities in the Northeast Operating Areas and experience behavioral harassment as a result of that exposure. We would not expect U.S. Navy vessels engaged in these training activities to strike a right whale.

North Atlantic right whales are not likely to respond to high-frequency sound sources associated with the proposed training activities, the evidence is equivocal on whether North Atlantic right whales are likely to respond upon being exposed to mid-frequency active sonar or the nature of any responses they might exhibit if they respond at all. The information available on right whales vocalizations suggests that right whales produce moans less than 400 Hz in frequency (Watkins and Schevill 1972; Thompson *et al.* 1979; Spero 1981), However, Nowacek *et al.* (2004) conducted controlled exposure experiments on North Atlantic right whales using ship noise, social sounds of conspecifics, 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. Although the alert stimulus caused whales to immediately cease foraging behavior and swim rapidly to the surface, Nowacek *et al*. offer no information on whether the whales were probably responding to the low- or mid-frequency components of the signals.

Although North Atlantic right whales appear to be able to hear mid-frequency (1 kHz–10 kHz) sounds, the limited evidence available suggests that sounds in this frequency range appear to lie at the periphery of their hearing range. The tonal vocalizations right whales produce can be divided into simple, low-frequency, stereo-typed calls and more complex, frequency-modulated, higher-frequency calls (Parks and Clark 2007). Most of these sounds range in frequency from 0.02 to 15 kHz, with dominant frequency ranges from 0.02 to less than 2 kHz with some sounds having multiple harmonics (Parks and Tyack 2005). Assuming that right whales will focus their attentional resources on the frequency ranges of their vocalizations, right whales seem less likely to devote attentional resources to stimuli in the frequency ranges of mid-frequency active sonar. As a result, they are not likely to respond physiologically or behaviorally to sounds in this frequency range.

Based on the evidence available, we conclude that the training activities the U.S. Navy plans to conduct on the Northeast Operating Areas and the Virginia Capes, Cherry Point, and Jacksonville Range Complexes from June 2011 to June 2012 and the active sonar training they plan to conduct along the Atlantic Coast are not likely to adversely affect the population dynamics, behavioral ecology, and social dynamics of individual North Atlantic right whales in ways or to a degree that would reduce their fitness. As we discussed in the *Approach to the Assessment* section of these Opinions, 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). As a result, we conclude that the mine warfare, surface warfare, small arms training, air warfare, amphibious warfare, electronic combat operations, and test and evaluations ordnance training activities the U.S. Navy plans to conduct along the Atlantic Coast from June 2011 to June 2012 and the active sonar training activities the Navy conducts along the Atlantic Coast each year would not appreciably reduce the North Atlantic right whale's likelihood of surviving and recovering in the wild.

SEI WHALES. Because of their pelagic distribution and low densities in the range complex, the U.S. Navy concluded that no sei whales are likely to be exposed to underwater detonations on the in the

Northeast Operating Areas or the Virginia Capes, Cherry Point, or Jacksonville Range Complexes and experience behavioral harassment or noise-induced loss of hearing sensitivity as a result of that exposure. However, each year we would expect no instances in which sei whales might be exposed to active sonar associated with the interrelated AFAST training activities and be "taken" as a result of that exposure. Like North Atlantic right whales, sei whales are not likely to be exposed to active sonar associated with surface ship mine warfare exercises, RONEX, or Gulf of Mexico exercises, which only occur in the Gulf of Mexico.

Like fin whales, sei whales in the action area seem likely to respond to the ship traffic associated with the activities the U.S. Navy plans to conduct in the Action Area in ways that approximate their responses to whale watch vessels. As discussed in the *Environmental Baseline* section of these Opinions, 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. Sei whales also 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 exercise 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 whales might not respond to the vessels, while in other circumstances, sei whales are likely to change their vocalizations, surface time, swimming speed, swimming angle or direction, respiration rates, dive times, feeding behavior, and social interactions (Amaral and Carlson 2005; Au and Green 2000, Cockeron 1995, Erbe 2002, Félix 2001, Magalhães *et al.* 2002, Richter *et al.* 2003, Scheidat *et al.* 2004, Simmonds 2005, Watkins 1986, Williams *et al.* 2002). 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 different exercises and the small number of times the exercises are likely to be repeated from June 2009 to June 2014, we do not expect these responses of sei whales to reduce the fitness of the sei whales that occur along the Atlantic Coast and in the Gulf of Mexico.

Based on the evidence available, we conclude that the training activities the U.S. Navy plans to conduct on the Northeast Operating Areas and the Virginia Capes, Cherry Point, and Jacksonville Range Complexes from June 2011 to June 2012 and the active sonar training they plan to conduct along the Atlantic Coast are not likely to adversely affect the population dynamics, behavioral ecology, and social dynamics of individual sei whales in ways or to a degree that would reduce their fitness. As we discussed in the *Approach to the Assessment* section of these Opinions, 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). As a result, we conclude that the mine warfare, surface warfare, small arms training, air warfare, amphibious warfare, electronic combat operations, and test and evaluations ordnance training activities the U.S. Navy plans to conduct along the Atlantic Coast from June 2011 to June 2012 and the active sonar training activities the Navy conducts along the Atlantic Coast each year would not appreciably reduce the sei whale's likelihood of surviving and recovering in the wild.

SPERM WHALES. Sperm whales would not be exposed to underwater detonations associated with U.S. Navy training activities in the Northeast Operating Areas or the Cherry Point or Jacksonville Range Complexes. However, the U.S. Navy concluded that 2 sperm whales might be exposed to underwater detonations on the Virginia Capes Range Complex and experience behavioral harassment or noise-induced loss of hearing sensitivity as a result of that exposure.

In addition, each year we would expect 10,734 instances in which sperm whales might be exposed to active sonar associated with the interrelated AFAST training activities and be "taken" as a result of that exposure. Like humpback whales, some of these exposure events are likely to occur in all Operating Area along the Atlantic coast of the United States and in the Gulf of Mexico, which means they are likely to result from exposure to any of the active sonar training activities the U.S. Navy proposed to conduct in the Action Area.

If exposed to mid- and high-frequency active sonar transmissions, sperm whales are likely to hear and respond to those transmissions. The only data on the hearing range of sperm whales are evoked potentials from a stranded neonate (Carder and Ridgway 1990). These data suggest that neonatal sperm whales respond to sounds from 2.5-60 kHz. Sperm whales also produce loud broad-band clicks from about 0.1 to 20 kHz (Weilgart and Whitehead 1993, 1997; Goold and Jones 1995). These have source levels estimated at 171 dB re 1 Pa (Levenson 1974). Current evidence suggests that the disproportionately large head of the sperm whale is an adaptation to produce these vocalizations (Norris and Harvey 1972; Cranford 1992; but see Clarke 1979). This suggests that the production of these loud low frequency clicks is extremely important to the survival of individual sperm whales. The function of these vocalizations is relatively well-studied (Weilgart and Whitehead 1993, 1997; Goold and Jones 1995). Long series of monotonous regularly spaced clicks are associated with feeding and are thought to be produced for echolocation. Distinctive, short, patterned series of clicks, called codas, are associated with social behavior and interactions within social groups (Weilgart and Whitehead 1993).

Based on the frequencies of their vocalizations, which overlap the frequency range of mid- and high-frequency active sonar, sonar transmissions might temporarily reduce the active space of sperm whale vocalizations. Most of the energy of sperm whales clicks is concentrated at 2 to 4 kHz and 10 to 16 kHz, which overlaps with the mid-frequency sonar. Other studies indicate sperm whales' wide-band clicks contain energy between 0.1 and 20 kHz (Weilgart and Whitehead 1993, Goold and Jones 1995). Ridgway and Carder (2001) measured low-frequency, high amplitude clicks with peak frequencies at 500 Hz to 3 kHz from a neonate sperm whale.

There is some evidence of disruptions of clicking and behavior from sonars (Goold 1999, Watkins and Scheville1975, Watkins *et al.* 1985), pingers (Watkins and Scheville 1975), the Heard Island Feasability Test (Bowles *et al.* 1994), 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 Scheville 1975). Goold (1999) reported six sperm whales that were driven through a narrow channel using ship noise, echosounder, and fishfinder emissions from a flotilla of 10 vessels. Watkins and Scheville (1975) 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).

As discussed previously, 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 *et al.* 1985). Captive bottlenose dolphins and a beluga 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 *et al.* 1997, Schlundt *et al.* 2000), and to shorter broadband pulsed signals (Finneran *et al.* 2000, 2002). 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 (Schlundt *et al.* 2000, Finneran *et al.* 2002). 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.* 2000, 2002). Test animals sometimes vocalized after exposure to pulsed, mid-frequency sound from a watergun (Finneran *et al.* 2002). In some instances, animals exhibited aggressive behavior toward the test apparatus (Ridgway *et al.* 1997, Schlundt *et al.* 2000). 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.* (2000).

Published reports identify instances in which sperm whales may 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.* (2000) 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. In one DTAG deployment in the northern Gulf of Mexico on July 28, 2001, researchers documented that the tagged whale moved away from an operating seismic vessel once the seismic pulses were received at the tag at roughly 137 dB re 1 Pa (Johnson and Miller 2002). 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.* 1994).

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 Pa 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, 1998, 2000, 2001, 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.

Sperm whales have been observed to frequently stop echolocating in the presence of underwater pulses made by echosounders and submarine sonar (Watkins and Schevill 1975; Watkins *et al.* 1985). 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).

Preliminary data from an experimental study of sperm whale reactions to seismic surveys in the Gulf of Mexico and a study of the movements of sperm whales with satellite-linked tags in relation to seismic surveys show that during two controlled exposure experiments in which sperm whales were exposed to seismic pulses at received levels up to 148 dB re 1 Pa over octave band with most energy, the whales did not avoid the vessel or change their feeding efficiency (National Science Foundation 2003). Although the sample size is small (4 whales in 2 experiments), the results are consistent with those off northern Norway.

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.* (1995) 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.

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.

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. For example, sperm whales have moved out of areas after the start of air gun seismic testing (Davis *et al.* 1995). 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 communicating, 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 active sonar training the U.S. Navy plans to conduct along the Atlantic Coast and in the Gulf of Mexico, 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.

Like fin and sei whales, individual sperm whales are also likely to respond to the ship traffic associated with the maneuvers might approximate their responses to whale watch vessels. As discussed in the *Environmental Baseline* section of these Opinions, 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 (using the Navy‘s estimates of the cumulative exposures to sounds equivalents > 173 dB as an index of potential exposures), 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 (Amaral and Carlson 2005; Au and Green 2000, Cockeron 1995, Erbe 2002, Félix 2001, Magalhães *et al.* 2002, Richter *et al.* 2003, Scheidat *et al.* 2004, Simmonds 2005, Watkins 1986, Williams *et al.* 2002). 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, we conclude that the training activities the U.S. Navy plans to conduct on the Northeast Operating Areas and the Virginia Capes, Cherry Point, and Jacksonville Range Complexes from June 2011 to June 2012 and the active sonar training they plan to conduct along the Atlantic Coast 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. As we discussed in the *Approach to the Assessment* section of these Opinions, an action that is not likely to reduce the fitness of individual sperm whales would not be likely to reduce the viability of the populations those individual whales represent by reducing the population dynamics, behavioral ecology, and social dynamics of those populations (that is, we would not expect reductions in the reproduction, numbers, or distribution of those populations). As a result, we conclude that the mine warfare, surface warfare, small arms training, air warfare, amphibious warfare, electronic combat operations, and test and evaluations ordnance training activities the U.S. Navy plans to conduct along the Atlantic Coast from June 2011 to June 2012 and the active sonar training activities the Navy conducts along the Atlantic Coast each year would not appreciably reduce the sperm whale’s likelihood of surviving and recovering in the wild.

SEA TURTLES.

The U.S. Navy concluded that 289 unspecified hardshell turtles (green, hawksbill, Kemp's ridley or loggerhead sea turtles) might be exposed to underwater detonations on the Virginia Capes Range Complex and experience behavioral harassment as a result of that exposure. Another 11 hardshell sea turtles might be exposed to underwater detonations at 182 dB re μPa2-s (or 23-pounds per square inch-msec, whichever was greater) which would elicit behavioral responses that we would result in a significant disruption in normal behavior patterns, such as breeding or feeding. Two hardshell sea turtles might be exposed to underwater detonations at 205 dB re μPa2-s (or 13-pounds per square inch-msec, whichever was greater) which would result in 50 percent of the animals experiencing rupture of their tympanic membrane; that is, that would constitute an injury that correlates with permanent, noise-induced loss of hearing sensitivity.

The U.S. Navy concluded that 540 Kemp's ridley sea turtles might be exposed to underwater detonations on the Virginia Capes Range Complex during bombing exercises and firing exercises) and experience behavioral harassment as a result of that exposure. Another 15 Kemp's ridley sea turtles might be exposed to underwater detonations on the Virginia Capes Range Complex and experience physiological stress responses as a result of their exposure. Five Kemp's ridley sea turtles might be exposed to underwater detonations and experience noise-induced hearing loss as a result of their exposure.

The U.S. Navy concluded that nine leatherback sea turtles might be exposed to underwater detonations on the Virginia Capes Range Complex (during bombing exercises) and experience behavioral harassment as a result of that exposure but that no other leatherback sea turtles would be exposed at levels that would cause physiological stress or tympanic rupture. The U.S. Navy also concluded that 429 loggerhead sea turtles might be exposed to underwater detonations on the Virginia Capes Range Complex during bombing and firing exercises and experience behavioral harassment as a result of that exposure. Another 37 loggerhead sea turtles might be exposed to underwater detonations on the Virginia Capes Range Complex and experience physiological stress responses as a result of their exposure. Eight loggerhead sea turtles might be exposed to underwater detonations at 205 dB re μPa2-s (or 13-pounds per square inch-msec, whichever was greater) which would result in 50 percent of the animals experiencing rupture of their tympanic membrane; that is, that would constitute an injury that correlates with permanent, noise-induced loss of hearing sensitivity.

The U.S. Navy concluded that no green, hawksbill, Kemp's ridley, leatherback or loggerhead sea turtles might be exposed to underwater detonations on the Cherry Point Range Complex and experience behavioral harassment, physiological stress responses, or noise-induced hearing loss as a result of that exposure.

The U.S. Navy concluded that six hardshell sea turtles (green, hawksbill, Kemp's ridley or loggerhead sea turtles) might be exposed to underwater detonations on the Jacksonville Range Complex (during firing exercises) and experience behavioral harassment as a result of that exposure, another five of these turtles might experience physiological stress responses as a result of their exposure to missile exercises while one hardshell sea turtle might be exposed to underwater detonations at 205 dB re μPa2-s (or 13-pounds per square inch-msec, whichever was greater) which would result in 50 percent of the animals experiencing rupture of their tympanic membrane; that is, that would constitute an injury that correlates with permanent, noise-induced loss of hearing sensitivity.

The information available has not allowed us to estimate the probability of the different sea turtles being exposed to mid-frequency active sonar, vessel traffic, or explosions associated with the active sonar training activities the U.S. Navy plans to conduct along the Atlantic Coast and in the Gulf of Mexico each year from June 2011 to June 2012.

Further, the information on the hearing capabilities of sea turtles is limited, although the information available suggests that the auditory capabilities of sea turtles are centered in the low-frequency range (<1 kHz) (Ridgway *et al.* 1969; Lenhardt *et al.* 1983; Bartol *et al.* 1999, Lenhardt 1994, O'Hara and Wilcox 1990). Ridgway *et al.* (1969) studied the auditory evoked potentials of three green sea turtles (in air and through mechanical stimulation of the ear) and concluded that their maximum sensitivity occurred from 300 to 400 Hz with rapid declines for tones at lower and higher frequencies. They reported an upper limit for cochlear potentials without injury of 2000 Hz and a practical limit of about 1000 Hz. This is similar to estimates for loggerhead sea turtles, which had most sensitive hearing between 250 and 1000 Hz, with rapid decline above 1000 Hz (Bartol *et al.* 1999).

These hearing sensitivities are similar to the hearing sensitivities reported for two terrestrial species: pond turtles (*Pseudemys scripta*) and wood turtles (*Chrysemys inscuplta*). Pond turtles are reported to have best hearing responsiveness 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). The wood turtle has sensitivities up to about 500 Hz, followed by a rapid decline above 1000 Hz and almost no responses beyond 3000 or 4000 Hz (Peterson 1966). We assume that these sensitivities to sound apply to the four hardshell turtles (i.e., green, Hawksbill, Kemp's ridley and loggerhead sea turtles). No audiometric data are available for leatherback sea turtles, but we assume that they have hearing ranges similar to those of other sea turtles (or at least, their hearing is more likely to be similar to other sea turtles than marine mammals). Based on this information sea turtles exposed to received levels of active mid-frequency sonar are not likely to hear mid-frequency sounds (sounds between 1 kHz and 10 kHz); therefore, they are not likely to respond physiologically or behaviorally to those received levels.

A recent study on the effects of airguns on sea turtle behavior also suggests that sea turtles are most likely to respond to low-frequency sounds. McCauley *et al.* (2000) reported that green and loggerhead sea turtles will avoid air-gun arrays at 2 km and at 1 km with received levels of 166 dB re 1 Pa and 175 db re 1 Pa, respectively. The sea turtles responded consistently: above a level of approximately 166 dB re 1 Pa rms the turtles noticeably increased their swimming activity compared to non-airgun operation periods. Above 175 dB re 1 Pa mean squared pressure their behavior became more erratic possibly indicating the turtles were in an agitated state. Because the sonar that would be used during the proposed exercises transmits at frequencies above hearing thresholds for sea turtles, sea 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 —may affect, but is not likely to adversely affect green, hawksbill, Kemp's ridley, leatherback, or loggerhead sea turtles.

Sea turtles along the Atlantic Coast or in the Gulf of Mexico might encounter one or more parachutes after they have been jettisoned from these sonobuoys and could become entangled as a result. We cannot, however, determine whether such interactions are probable, given the relatively small number of sonobuoys that would be employed in each of the exercises, the relatively large geographic area involved, and the relatively low densities of sea turtles that are likely to occur in the Action Area. Given the large size of the Action Area, the relatively small number of sonobuoys that would be employed in an exercise, and the relatively low densities of sea turtles, an interaction between sea turtles and parachutes seems to have a very small probability; however, despite a very small probability, an interaction could be fatal to the sea turtle if it was entangled and drowned or if it swallowed a parachute.

Nevertheless, we conclude that the training activities the U.S. Navy plans to conduct on the Northeast Operating Areas and the Virginia Capes, Cherry Point, and Jacksonville Range Complexes from June 2011 to June 2012 and the active sonar training they plan to conduct along the Atlantic Coast are not likely to interact with sufficient number of adult or sub-adult sea turtles, if they interact with any sea turtles at all, to reduce the viability of the nesting aggregations those sea turtles represent by reducing the population dynamics, behavioral ecology, and social dynamics of those populations (that is, we would not expect reductions in the reproduction, numbers, or distribution of those populations). As a result, those activities would not be expected to appreciably reduce the likelihood of green, hawksbill, Kemp's ridley, leatherback, or loggerhead sea turtles surviving and recovering in the wild by reducing their reproduction, numbers, or distribution.

NORTH ATLANTIC RIGHT WHALE CRITICAL HABITAT. Because the U.S. Navy does not propose to conduct active sonar training in North Atlantic right whale critical habitat (with exceptions that have been noted elsewhere in these Opinions) and the U.S. Navy does not plan to conduct active sonar activities within the Stellwagen Bank, Monitor, Gray's Reef, Flower Garden Banks, and Florida Keys National Marine Sanctuaries and will avoid these sanctuaries by observing a 5 km (2.7 nautical mile or nm) buffer, we assume that these areas are not likely to be exposed to vessel traffic associated with active sonar training. Therefore, the conservation value of these areas should not be affected by vessel traffic.

The U.S. Navy also proposes to reduce the time spent conducting object detection exercises in the North Atlantic right whale critical habitat (Item 4.5.2 of the Navy's proposed mitigation measures), although maritime security operations would increase in these areas. The Navy, however, proposes to require ships to contact FACSFAC JAX to obtain the latest right whale sighting information. FACSFAC JAX will advise ships of all reported whale sightings in the vicinity of the critical habitat and Associated Area of Concern prior to conducting surface ship object detection exercises in the southeast North Atlantic right whale critical habitat from 15 November to 15 April. To the extent operationally feasible, ships will avoid conducting training in the vicinity of recently sighted right whales. Ships will maneuver to maintain at least 457 m (500 yd) separation from any observed whale, consistent with the safety of the ship. Further, the U.S. Navy has established protocols that would make personnel aboard their ships aware of the distribution of North Atlantic right whales, to increase their probability of detecting right whales (for example, by requiring at least two watchstanders on ships transiting within 56 km of the mid-Atlantic coast), and operating at slow, safe speeds.

Because of the Navy's mitigation measures, the northern units of right whale critical habitat would not be exposed to mid-frequency active sonar at received levels greater than about 170 dB (based on estimates of propagation distances and assuming that a vessel near the boundary of this buffer zone would be transmitting active sonar). Because North Atlantic right whales are not likely to respond to high-frequency sound sources associated with the proposed training activities, high-frequency sound sources associated with the Navy's active sonar training activities should not reduce the conservation value of the designated critical habitat. Although North Atlantic right whales appear to be able to hear mid-frequency (1 kHz–10 kHz) sounds, the limited evidence available suggests that sounds in this frequency range appear to lie at the periphery of their hearing range and they do not appear likely to respond physiologically or behaviorally to sounds in this frequency range. As a result, the mid-frequency sound sources associated with the Navy's active sonar training activities along the Atlantic Coast should not reduce the conservation value of the designated critical habitat for right whales.

Conclusions

Conclusion for Listed Resources

After reviewing the current status of endangered blue whales, fin whales, humpback whales, North Atlantic right whales, sei whales, sperm whales, threatened green sea turtles, endangered hawksbill sea turtles, endangered leatherback sea turtles, endangered Kemp's ridley, and threatened loggerhead sea turtles, the environmental baseline for the action area, the effects of the training activities the U.S. Navy plans to conduct in the Northeast Operating Areas, the Virginia Capes Range Complex, Cherry Point Range Complex, and the Jacksonville Range Complex from June 2011 through June 2012 and the National Marine Fisheries Service's Permits, Conservation, and Education Division proposal to issue Letters of Authorization to the U.S. Navy to take marine mammals for a one-year period beginning in June 2011 and ending in June 2012 it is NMFS' opinion that these activities are likely to adversely affect but are not likely to jeopardize the continued existence of these threatened and endangered species under NMFS' jurisdiction.

This opinion also concludes that training activities the U.S. Navy plans to conduct in the Northeast Operating Areas, the Virginia Capes Range Complex, Cherry Point Range Complex, and the Jacksonville Range Complex from June 2011 through June 2012 and the National Marine Fisheries Service's Permits, Conservation, and Education Division proposal to issue letters of authorization to the U.S. Navy to take marine mammals for a one-year period beginning in June 2011 and ending in June 2012 incidental to the U.S. Navy's training activities 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 action area.

Conclusion for Proposed Resources

After reviewing the current status of the proposed Northwest Atlantic distinct population segment of loggerhead sea turtles, the environmental baseline for the action area, the effects of the the effects of the training activities the U.S. Navy plans to conduct in the Northeast Operating Areas, the Virginia Capes Range Complex, Cherry Point Range Complex, and the Jacksonville Range Complex and the National Marine Fisheries Service's Permits, Conservation, and Education Division proposal to issue Letters of Authorization to the U.S. Navy to take marine mammals for a one-year period beginning in June 2011 and ending in June 2012, it is NMFS' conference opinion that these activities are likely to adversely affect but are not likely to jeopardize the continued existence of these threatened and endangered species under NMFS' jurisdiction.

Incidental Take Statement

Section 9 of the ESA and Federal regulation pursuant to section 4(d) of the ESA prohibits 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 terms of section 7(b)(4) and section 7(o)(2) of the ESA, taking that is incidental to and not intended as part of the agency action is not considered to be prohibited taking under the Act provided that such taking is in compliance with the terms and conditions of this Incidental Take Statement.

The measures described below, which are non-discretionary, must be implemented by NMFS‘ Permits, Conservation and Education Division so they become binding conditions of any permit issued to the U.S. Navy, as appropriate, in order for the exemption in section 7(o)(2) to apply. NMFS’ Permits, Conservation, and Education Division has a continuing duty to regulate the activity covered by this Incidental Take Statement. If NMFS’ Permits, Conservation and Education Division (1) fails to require the U.S. Navy to adhere to the terms and conditions of the Incidental Take Statement through enforceable terms that are added to the permit or grant document, and/or (2) fails to retain oversight to ensure compliance with these terms and conditions, the protective coverage of section 7(o)(2) may lapse.

Amount or Extent of Take Anticipated

The section 7 regulations require NMFS to estimate the number of individuals that may be taken by proposed actions 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 difficult to estimate because we have no empirical information on (a) the actual number of listed species that are likely to occur in the different sites, (b) the actual number of individuals of those species that are likely to be exposed, (c) the circumstances associated with any exposure, and (d) the range of responses we would expect different individuals of the different species to exhibit upon exposure.

The instances of harassment identified in Table 18 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 and, therefore, would represent significant disruptions of the normal behavioral patterns of the animals that have been exposed. The instances of harm identified in Table 18 would generally represent animals that would have been exposed to underwater detonations at 205 dB re μPa^2-s or 13 psi, which corresponds to an exposure in which 50 percent of the animals would be expected to experience rupture of their tympanic membrane, an injury that correlates with measures of permanent hearing impairment (specifically, a 30 percent incidence of permanent loss of hearing sensitivity or PTS; Ketten 1998).

No whales are likely to die or be wounded as a result of their exposure to U.S. Navy training activities in the Northeast Operating Area, Virgina Capes Range Complex, Cherry Point Range Complex, or Jacksonville Range Complex.

Table 18. The number of different endangered and threatened species that are likely to be "taken" in the form of harassment or harm as a result of their exposure to the training activitie considered in this Opinion. Species of sea turtles included in the category "hardshell" sea turtles includes green, hawksbill, Kemp's ridley and loggerhead sea turtles. This table does not include the individuals that are likely to be "taken" as a result of their exposure to mid-frequency active sonar; those "take" estimates were identified in the Incidental Take Statement of our January 2010 Opinion on the Atlantic Fleet Active Sonar Training activities.

Species	Areas							
	Northeast		Virginia Capes		Cherry Point		Jacksonville	
	Harass	harm	Harass	Harm	Harass	Harm	Harass	Harm
Blue whale	0	0	0	0	0	0	0	0
Fin whale	0	0	2	0	0	0	0	0
Humpback whale	0	0	2	0	0	0	0	0
North Atlantic right whale	0	0	0	0	0	0	0	0
Sei whale	0	0	0	0	0	0	0	0
Sperm whale	0	0	2	0	0	0	0	0
Hardshell sea turtles	0	0	300	2	0	0	11	1
Kemp's ridley sea turtle	0	0	555	5	0	0	2	0
Leatherback sea turtle	0	0	9	0	0	0	11	1
Loggerhead sea turtle	0	0	466	8	0	0	19	1

Effect of the Take

In the accompanying biological opinion, NMFS determined that the number of individuals that might be exposed to the training activities the U.S. Navy plans to conduct along the Atlantic Coast of the United States and are likely to respond to that exposure in ways that NMFS would classify as "take" as that term is defined pursuant to section 3 of the Endangered Species Act is not likely to jeopardize the continued existence of blue, fin, humpback, North Atlantic right, sei, sperm whales or green, hawksbill, Kemp's ridley, leatherback, or loggerhead sea turtles. Although the biological significance of the animal's behavioral responses remains unknown, exposure to these training activities 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 stressors associated with these training activities are expected to be temporary and would not affect the reproduction, survival, or recovery of these species.

Reasonable and Prudent Measures

The National Marine Fisheries Service believes the following reasonable and prudent measures are necessary and appropriate to minimize the impacts of incidental take on threatened and endangered species:

1. The U.S. Navy shall submit reports that identify the general location, timing, number of hours, and other aspects of the training activities the U.S. Navy plans to conduct along the Atlantic Coast of the United States over the next twelve months.

Terms and Conditions

In order to be exempt from the prohibitions of section 9 of the Endangered Species Act of 1973, as amended, NMFS' Permits, Conservation and Education Division and the U.S. Navy must comply with the following terms and conditions, which implement the reasonable and prudent measures described above and outlines the reporting requirements required by the section 7 regulations (50 CFR 402.14(i)).

1. Annual Virginia Capes Range Complex, Cherry Point Range Complex and Jacksonville Range Complex Monitoring Plan Reports - The Navy shall submit a report (or a multi-Range Complex Annual Monitoring Plan Report, if that is how the Navy chooses to submit the information) annually on March 1 describing the implementation and results (through January 1 of the same year) of the VACAPES Range Complex Monitoring Plan, Cherry Point Monitoring Plan and the Jacksonville Monitoring Plan. Data collection methods will be standardized across range complexes to allow for comparison in different geographic locations. Although additional information will also be gathered, the MMOs collecting marine mammal data pursuant to the applicable Range Complex Monitoring Plan shall, at a minimum, provide the same marine mammal observation data required in 50 C.F.R. §218.5(g). The Range Complex Monitoring Plan Reports may be provided to NMFS within a larger report that includes the required Monitoring Plan Reports for all three range complexes.

2. Annual Virginia Capes Range Complex, Cherry Point Range Complex and Jacksonville Range Complex Exercise Reports - The Navy shall provide the information described below for all of their explosive exercises. Until the Navy is able to report in full the information below, they shall provide an annual update on the Navy's explosive tracking methods, including improvements from the previous year.

   (i) Total annual number of each type of explosive exercise (of those identified as part of the "specified activity" in the Letters of Authorization) conducted in the Virginia Range Complex, Cherry Point Range Complex and Jacksonville Range Complexes.

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

CONSERVATION RECOMMENDATIONS

Section 7(a)(1) of the Act directs Federal agencies to utilize their authorities to further the purposes of the Act 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. The following conservation recommendations would provide information for future consultations involving the issuance of marine mammal permits that may affect endangered whales as well as reduce harassment related to research activities:

1. *Cumulative Impact Analysis.* The U.S. Navy should work with NMFS Endangered Species Division and other relevant stakeholders (the Marine Mammal Commission, International Whaling Commission, and the marine mammal research community) to develop a method for assessing the cumulative impacts of anthropogenic noise on cetaceans, pinnipeds, sea turtles, and other marine animals. This includes the cumulative impacts on the distribution, abundance, and the physiological, behavioral and social ecology of these species.

In order to keep NMFS Endangered Species Division informed of actions minimizing or avoiding adverse effects or benefitting listed species or their habitats, the U.S. Navy should notify the Endangered Species Division of any conservation recommendations they implement in their final action.

REINITIATION NOTICE

This concludes formal consultation and conference on the training activities the U.S. Navy plans to conduct in the Northeast Operating Area, the Virginia Capes Range Complex, Cherry Point Range Complex, and the Jacksonville Range Complex from June 2011 through June 2012 the the National Marine Fisheries Service's Permits, Conservation, and Education Division's proposal to issue Letters of Authorization to allow the U.S. Navy to "take" marine mammals incidental to these training activities. 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, section 7 consultation must be reinitiated immediately.

The U.S. Navy and NMFS' Permits, Education, and Conservation Division may ask NMFS' Endangered Species Division to confirm the conference opinion as a biological opinion issued through formal consultation if the Northwest Atlantic distinct population segment of loggerhead sea turtles is listed. The request must be in writing. If NMFS' Endangered Species Division reviews the proposed action and finds that there have been no significant changes in the action as planned or in the information used during the conference, NMFS' Endangered Species Division will confirm the conference opinion as the biological opinion for the Virgina Capes, Cherry Point and Jacksonville Range Complex activities and no further section 7 consultation will be necessary.

Literature Cited

Adler-Fenchel, H.S. 1980. Acoustically derived estimate of the size distribution for a sample of sperm whales (*Physeter catodon*) in the Western North Atlantic. Canadian Journal of Fisheries and Aquatic Sciences 37:2358-2361.

Adler-Fenchel, H.S. 1980. Acoustically derived estimate of the size distribution for a sample of sperm whales (*Physeter catodon*) in the Western North Atlantic. Canadian Journal of Fisheries and Aquatic Sciences 37:2358-2361.

Advanced Research Projects Agency, and NOAA, National Marine Fisheries Service. 1995. Final Environmental Impact Statement/Environmental Impact Report for the Kauai Acoustic Thermometry of Ocean Climate Project and its associated Marine Mammal Research Program, Vols. I and II. Advanced Research Projects Agency, Arlington, Virginia; NOAA, National Marine Fisheries Service, Silver Spring, Maryland.

Agler, B.A., R.L. Schooley, S.E. Frohock, S.K. Katona, and I.E. Seipt. 1993. Reproduction of photographically identified fin whales, *Balaenoptera physalus*, from the Gulf of Maine. Journal of Mammology 74:577-587.

Aguayo L.A. 1974. Baleen whales off continental Chile. Pages 209-217. In: W.E. Schevill (editor) The whale problem: a status report. Harvard University Press, Cambridge, Massachusetts.

Aguilar, A., and C. Lockyer. 1987. Growth, physical maturity, and mortality of fin whales (*Balaenoptera physalus*) inhabiting the temperate waters of the northeast Atlantic. Canadian Journal of Zoology 65:253-264.

Allen, K.R. 1980. Conservation and management of whales. University of Washington Press, Seattle; Washington.

Allen, K.R. 1980. Size distribution of male sperm whales in the pelagic catches. Reports of the International Whaling Commission Special Issue 2: 51-56.

Anderson, J. J. 2000. A vitality-based model relating stressors and environmental properties to organism survival. Ecological Monographs 70:445-470.

André, M., M. Terada and Y. Watanabe. 1997. Sperm whale (*Physeter macrocephalus*) behavioral response after the playback of artificial sounds. Reports of the International Whaling Commission 47: 499 - 504.

Andrews, R.C. 1916. The sei whale (*Balaenoptera borealis* Lesson). Memoir of the American Museum of Natural History New Series 1(6):291-388.

Apple, T.C. 2001. Spatial and temporal variation of sperm whale (*Physeter macrocephalus*) codas in the northern

Gulf of Mexico. The Journal of the Acoustical Society of America 109(5 2): 2390.

Arnbom, T., V. Papstavrou, L.S. Weilgart and H. Whitehead. 1987. Sperm whales react to an attack by killer whales. Journal of Mammalogy 68(2): 450-453.

Ashford, J.R. and A.R. Martin. Interactions between cetaceans and longline fishery operations around South Georgia. Marine Mammal Science 12(3):452-457.

Atkins, N., and S. L. Swartz (eds.). 1989. Proceedings of the workshop to review and evaluate whale watching programs and management needs. November 14-16, 1988, Monterey, California. Center for Marine Conservation., Washington D.C.

Atlantic Sturgeon Status Review Team. 2007. Status Review of Atlantic sturgeon (*Acipenser oxyrinchus oxyrinchus*). Report to National Marine Fisheries Service, Northeast Regional Office. February 23, 2007. 174 pp.

Au, W. W. L. 1997. Some hot topics in animal bioacoustics. The Journal of the Acoustical Society of America 101:10.

Au, W. W. L., A. Frankel, D. A. Helweg, and D. H. Cato. 2001. Against the humpback whale sonar hypothesis. IEEE Journal of Oceanic Engineering 26:5.

Au, W. W. L., A.A. Pack, M.O. Lammers, L.M. Herman, M.H. Deakos, and K. Andrews. 2006. Acoustic properties of humpback whale songs. The Journal of the Acoustical Society of America 120: 1103 – 1110.

Au, W. W. L., and K. J. Benoit-Bird. 2003. Automatic gain control in the echolocation system of dolphins. Nature 423:861-863.

Au, W. W. L., and P. E. Nachtigall. 1997. Acoustics of echolocating dolphins and small whales. Marine Behavior and Physiology 29:36.

Au, W. W. L., L. N. Andersen, A. R. Rasmussen, H. L. Roitblat, and P. E. Nachtigall. 1995. Neural network modeling of a dolphin‘s sonar discrimination capabilities. The Journal of the Acoustical Society of America 98:8.

Au, W., and M. Green. 2000. Acoustic interaction of humpback whales and whale-watching boats. Marine Environmental Research 49:469-481.

Au, W.W.L., P. Nachtigall, and J.L. Pawloski. 1997. Acoustic effects of the ATOC signal (75 Hz, 195 dB) on dolphins and whales. Journal of the Acoustical Society of America 101:2973-2977.

Backus, R.H. and W.E. Schevill. 1966. Physeter clicks. p.510-528 In: K.S. Norris (editor) Whales, Dolphins, and Porpoises. University of California Press; Berkeley, California.

Baker, C.S. and L.M. Herman. 1987. Alternative population estimates of humpback whales (*Megaptera novaeangliae*) in Hawaiian waters. Canadian Journal of Zoology 65(11): 2818-2821.

Baker, C.S. L.M. Herman, B.G. Bays and G.B. Bauer. 1983. The impact of vessel traffic on the behavior of humpback whales in southeast Alaska: 1982 season. Report submitted to the National Marine Mammal Laboratory, Seattle, Washington.

Baker, C.S., A. Perry and L.M. Herman. 1987. Reproductive histories of female humpback whales (*Megaptera novaeangliae*) in the North Pacific. Marine Ecology Progress Series 41: 103-114.

Baker, C.S., A. Perry, J.L. Bannister, M.T. Weinrich, R.B. Abernethy, J. Calambokidis, J. Lien, R.H. Lambertsen, J. Urban Ramirez, O. Vasquez, P.J. Clapham, A. Alling, S.J. O'Brien and S.R. Palumbi. 1993. Abundant mitochondrial DNA variation and world-wide population structure in humpback whales. Proceedings of the National Academy of Science of the United States of America 90(17): 8239-8243.

Baker, C.S., D.A. Gilbert, M.T. Weinrich, R.H. Lambertsen, J. Calambokidis, B. McArdle, G.K. Chambers and J. O'Brien. 1993. Population characteristics of DNA fingerprints in humpback whales (*Megaptera novaeangliae*). Journal of Heredity 84: 281-290.

Baker, C.S., R.W. Slade, J.L. Bannister, B. Abernethy, M.T. Weinrich, J. Lien, J. Urban, P.J. Corkeron, J. Calambokidis, O. Vasquez and S.R. Palumbi. 1994. Hierarchical structure of mitochondrial DNA gene flow among humpback whales *Megaptera novaeangliae*, world-wide. Molecular Ecology 3: 313-327.

Baker, C.S., S.R. Palumbi, R.H. Lambertsen, M.T. Weinrich, J. Calambokidis and J. O'Brien. 1990. Influence of seasonal migration on geographic distribution of mitochondrial DNA haplotypes in humpback whales. Nature 344(15): 238-240.

Balcomb, K.C. 1987. The whales of Hawai‘i, including all species of marine mammals in Hawai’ian and adjacent waters. Marine Mammal Fund Publication; San Francisco, California.

Ballance, L.T., R.C. Anderson, R.L. Pitman, K. Stafford, A. Shaan, Z. Waheed and R.L. Brownell, Jr. 2001. Cetacean sightings around the Republic of the Maldives, April 1998. Journal of Cetacean Research and Management 3(2): 213 - 218.

Bannister, J.L. 1994. Continued increase in humpback whales off Western Australia. Reports of the International Whaling Commission 44: 309-310.

Bannister, J.L. and E. Mitchell. 1980. North Pacific sperm whale stock identity: distributional evidence from Maury and Townsend charts. Reports of the International Whaling Commission Special Issue No. 2: 219-223

Bannister, J.L., G.P. Kirkwood and S.E. Wayte. 1991. Increase in humpback whales off western Australia. Reports of the International Whaling Commission 41: 461-465.

Barlow, J. 1994. Abundance of large whales in California coastal waters: a comparison of ship surveys in 1979/80 and in 1991. Report of the International Whaling Commission 44. 399-406.

Barlow, J. 1995. The abundance of cetaceans in California waters. Part I: Ship surveys in summer and fall 1991. Fishery Bulletin 93: 1-14.

Barlow, J., K. A. Forney, P. S. Hill, R. L. Brownell, Jr., J. V. Carretta, D. P. DeMaster, F. Julian, M. S. Lowry, T. Ragen, and R. R. Reeves. 1997. U.S. Pacific marine mammal stock assessment: 1996. NOAA Technical Memorandum NMFS-SWFSC-248. U.S. Department of Commerce, National Oceanic and Atmospheric Administration, National Marine Fisheries Service, Southwest Fisheries Science Center; La Jolla, California.

Barlow, J., R.L. Brownell, D.P. DeMaster, K.A. Forney, M.S. Lowry, S. Osmek, T.J. Ragen, R.R. Reeves, and R.J. Small. 1995. U.S. Pacific marine mammal stock assessments 1995. NOAA Technical Memorandum NMFS SWFSC-219. U.S. Department of Commerce, National Oceanic and Atmospheric Administration, National Marine Fisheries Service, Southwest Fisheries Science Center; La Jolla, California.

Barthol, S.M., J. Musick, and M.L. Lenhardt. 1999. Auditory evoked potentials of the loggerhead sea turtle (*Caretta caretta*). Copeia 1999(3): 836-840.

Bartol, S.M. and D.R. Ketten. 2006. Turtle and tuna hearing. In: *Sea turtle and pelagic fish sensory biology:developing techniques to reduce sea turtle bycatch in longline fisheries*. Edited by Y. Swimmer and R. Brill. U.S. Department of Commerce, National Oceanic and Atmospheric Administration, National Marine Fisheries Service, Pacific Islands Fisheries Science Center; Honolulu, Hawaii.

Bass, A.L., S.P. Epperly, J. Braun, D.W. Owens and R.M. Patterson. 1998. Natal origin and sex ratios of foraging sea turtles in the Pamlico-Albemarle Estuarine Complex. NOAA Technical Memorandum NMFS-SEFSC-415. U.S. Department of Commerce, National Oceanic and Atmospheric Administration, National Marine Fisheries Service, Southeast Fisheries Science Center; Miami, Florida.

Bauer, G.B. 1986. The behavior of humpback whales in Hawai’i and modification of behavior induced by human interventions. Unpublished doctoral dissertation; University of Hawai’i, Honolulu.

Bauer, G.B. and L.M. Herman. 1986. Effects of vessel traffic on the behavior of humpback whales in Hawai'i. Report Submitted to NMFS Southwest Region, U.S. Department of Commerce, National Oceanic and Atmospheric Administration, National Marine Fisheries Service, Southwest Fisheries Science Center, Western Pacific Program Office; Honolulu, Hawai'i.

Beach, D.W., and M.T. Weinrich. 1989. Watching the whales: Is an educational adventure for humans turning out to be another threat for endangered species? Oceanus 32(1):84-88.

Beale, C. M., and P. Monaghan. 2004. Human disturbance: people as predation-free predators? Journal of Applied Ecology 41:335-343.

Berzin, A.A. 2007. Scientific report for "Dalniy Vostok" and "Vladivostok" for 1971. Page 23. In: *Scientific reports of Soviet whaling expeditions in the North Pacific, 1955-1978*. *NOAA Technical Memorandum NMFSAFSC-175*. Edited by Y.V. Ivashchenko, P.J. Clapham and R.L. Brownell Jr. U.S. Department of Commerce, National Oceanic and Atmospheric Administration, National Marine Fisheries Service, Alaska Fisheries Science Center; Seattle, Washington.

Berzin, A.A. 2007. Subject No. 12. Whale stock status in the North Pacific in 1973. Pages: 26-27. In: *Scientific reports of Soviet whaling expeditions in the North Pacific, 1955-1978*. *NOAA Technical Memorandum NMFS-AFSC-175*. Edited by Y.V. Ivashchenko, P.J. Clapham and R.L. Brownell Jr. U.S. Department of Commerce, National Oceanic and Atmospheric Administration, National Marine Fisheries Service, Alaska Fisheries Science Center; Seattle, Washington.

Berzin, A.A. 2007. Whale stock status in the North Pacific and Antarctica in 1977. Page 33. In: *Scientific reports of Soviet whaling expeditions in the North Pacific, 1955-1978*. *NOAA Technical Memorandum NMFS-AFSC-175*. Edited by Y.V. Ivashchenko, P.J. Clapham and R.L. Brownell Jr. U.S. Department of Commerce, National Oceanic and Atmospheric Administration, National Marine Fisheries Service, Alaska Fisheries Science Center; Seattle, Washington.

Berzin, A.A. 2007. Whale stock status in the North Pacific in 1975. Pages: 30-32. In: *Scientific reports of Soviet whaling expeditions in the North Pacific, 1955-1978*. *NOAA Technical Memorandum NMFS-AFSC-175*. Edited by Y.V. Ivashchenko, P.J. Clapham and R.L. Brownell Jr. U.S. Department of Commerce, National Oceanic and Atmospheric Administration, National Marine Fisheries Service, Alaska Fisheries Science Center; Seattle, Washington.

Bowles, A.E., M. Smultea, B. Wursig, D.P. DeMaster, D. Palka. 1994. Abundance of marine mammals exposed to transmissions from the Heard Island Feasibility Test. Journal of the Acoustical Society of America 96(4):2469-2482.

Branch, T.A. and D.S. Butterworth. 2001. Estimates of abundance south of 60°S for cetacean species sighted frequently on the 1978/79 to 1997/98 IWC/IDCR-SOWER sighting surveys. Journal of Cetacean Research and Management 3(3): 251 - 270.

Bräutigam, A. and K.L. Eckert. 2006. Turning the tide: exploitation, trade and management of marine turtles in the Lesser Antilles, Central America, Colombia and Venezuela. TRAFFIC International and the Secretariat of the Convention on International Trade in Endangered Species; Cambridge, United Kingdom.

Buck, J.R., and P.L. Tyack. 2000. Response of gray whales to low-frequency sound. Journal of the Acoustical Society of America 107 (5): 2744.

Carder, D.A. and S.H. Ridgway. 1990. Auditory brainstem response in a neonatal sperm whale Physeter spp. Journal of the Acoustical Society of America Supplement 1:88.

Carretta, J.V., and K.A. Forney. 1993. Report on two aerial surveys for marine mammals in California coastal waters utilizing a NOAA DeHavilland Twin Otter aircraft: March 9- April 7, 1991 and February 8-April 6, 1992. NOAA Technical Memorandum NMFS-SWFSC-185; La Jolla, California.

Carretta, J.V., K.A. Forney, E. Oleson, K. Martien, M.M. Muto, M.S. Lowry, J. Barlow, J. Baker, B. Hanson, D. Lynch, L. Carswell, R.L. Brownell Jr., J. Robbins, D.K.. Mattila, K. Ralls,and M.C. Hill. 2011. Draft U.S. Pacific Marine Mammal Stock Assessments: 2010. U.S. Department of Commerce, NOAA Technical Memorandum NMFS-SWFSC-xxx. 303p.

Caswell, H. 1980. On the equivalence of maximizing reproductive value and maximizing fitness. Ecology 6:19-24.

Caswell, H. 1982. Optimal life histories and the maximization of reproductive value: a general theorem for complex life cycles. Ecology 63:1218-1222.

Caswell, H. 2001, Matrix population models. Sunderland, Massachusetts, Sinauer Publishers, Inc.

Cato, D.H. and R.C. McCauley. 2001. Ocean ambient noise from anthropogenic and natural sources in the context of marine mammal acoustics. Journal of the Acoustical Society of America 110: 2751.

Caut, S., E. Guirlet, E. Angular, K. Das and M. Girondot. 2008. Isotope analysis reveals foraging area dichotomy for Atlantic leatherback turtles. Public Library of Science (PLoS) One 3(3):e1845.

Cetacean and Turtle Assessment Program. 1982. A characterization of marine mammals and turtles in the mid- and north Atlantic areas of the U.S. Outer Continental Shelf. Report prepared by the University of Rhode Island School of Oceanography for the U.S. Department of the Interior, Bureau of Land Management; Washington, D.C.

Charif, R.A., D.K. Mellinger, K.J. Dunsmore, and C.W. Clark. Submitted. Source levels and depths of fin whale (*Balaenoptera physalus*) vocalizations from the eastern North Pacific.

Cherfas, J. 1989. The hunting of the whale. Viking Penguin Inc.; New York, New York.

Christal, J. and H. Whitehead. 1997. Aggregations of mature male sperm whales on the Galapagos Islands breeding ground. Marine Mammal Science 13(1): 11.

Christal, J. and H. Whitehead. 2001. Social affiliations within sperm whale (*Physeter macrocephalus*) groups. Ethology 107(4): 18.

Christal, J., H. Whitehead and E. Lettevall. 1998. Sperm whale social units: variation and change. Canadian Journal of Zoology 76(8): 10.

Clapham, P.J. 1999. *Megaptera novaeangliae*. Mammalian Species 604: 1-9.

Clapham, P.J. and D.K. Mattila. 1993. Reaction of humpback whales to skin biopsy sampling on a West Indies breeding ground. Marine Mammal Science, 9(4):382-391.

Clapham, P.J., and R.L. Brownell, Jr. 1996. Potential for interspecific competition in baleen whales. Reports of the International Whaling Commission 46:361-367.

Clark, C.W. and K.M. Firstrup. 2001. Baleen whale responses to low-frequency human-made underwater sounds. Journal of the Acoustical Society of America 110: 2751.

Clark, C.W. and K.M. Fristrup. 1997. Whales _95: A combined visual and acoustic survey of blue and fin whales off southern California. Reports of the International Whaling Commission 47: 583-600.

Clark, C.W., C.J. Gagnon and D.K. Mellinger. 1993. Whales _93: Application of the Navy IUSS for low-frequency marine mammal research. Invited paper, abstract published in Tenth Biennial conference on the Biology of Marine Mammals abstracts, 11-15 November 1993, Galveston, Texas. (Abstract)

Clark, C.W., Tyack P., Ellison W.T. 1998. Low-frequency sound scientific research program. Phase I: Responses of blue and fin whales to SURTASS LFA, southern California Bight. Quick Look Report. Marine Acoustics Inc.; Washington, D.C.

Clarke, J.T. and S.A. Norman. 2005. Results and evaluation of the US Navy shock trial environmental mitigation of marine mammals and sea turtles. Journal of Cetacean Research and Management 7(1): 43 - 50.

Clarke, M.R. 1976. Observation on sperm whale diving. Journal of the Marine Biology Association UK 56: 809-810.

Clarke, M.R. 1979. The head of the sperm whale. Scientific American 240(1): 106-117.

Clarke, R. 1956. Sperm whales of the Azores. Discovery Reports 28, 237-298.

Coakes, A. and H. Whitehead. 2004. Social structure and mating system of sperm whales off northern Chile. Canadian Journal of Zoology 82: 10.

Conner, R.C. and R.S. Smolker. 1985. Habituated dolphins (*Tursiops* sp.) in western Australia. Journal of Mammalogy 66(2):398-400.

Couch, L.K. 1930. Humpback whale killed in Puget Sound, Washington. The Murrelet 11(3): 75.

Cowlishaw, g., M.J. Lawes, M. Lightbody, A. Martin, R. Pettifor and J.M. Rowcliffe. 2004. A simple rule for the costs of vigilance: empirical evidence from a social forager. Proceedings of the Royal Society of London, Series B: Biological Sciences 271:27-33.

Cranford, T.W. 1992. Directional asymmetry in the Odontocete forehead. American Zoologist 32(5): 140A.

Croll, D.A., B.R. Tershy, A. Acevedo, and P. Levin. 1999. Marine vertebrates and low frequency sound. Unpublished technical report for the U.S. Navy's Environmental Impact Statement on Low Frequency Active Sonar. Marine Mammal and Seabird Ecology Group, Institute of Marine Sciences, University of California, Santa Cruz; Santa Cruz, California.

Crum, L.A. and Y. Mao. 1996. Acoustically enhanced bubble growth at low frequencies and implication for human

diver and marine mammal safety. Journal of the Acoustical Society of America 99: 2898-2907.

Cudahy, E., and W.T. Ellison. 2001. A review of the potential for in vivo tissue damage by exposure to underwater sound. Unpublished report prepared for National Marine Fisheries Service, Office of Protected Resources.

Silver Spring, Maryland.

Cummings, W.C. and P.O. Thompson. 1971. Underwater sounds from the blue whale *Balaenoptera musculus*. Journal of the Acoustical Society of America 50(4):1193-1198.

Cummings, W.C. and P.O. Thompson. 1977. Long 20-Hz sounds from blue whales in the northeast Pacific. Abstracts of the Second Conference on the Biology of Marine Mammals, San Diego, USA, December 1977.

Cummings, W.C. and P.O. Thompson. 1994. Characteristics and seasons of blue and finback whale sounds along the U.S. west coast as recorded at SOSUS stations. Journal of the Acoustical Society of America 95: 2853.

Curtis, K.R., B.M. Howe, and J.A. Mercer. 1999. Low-frequency ambient sound in the North Pacific: long time series observations. Journal of the Acoustical Society of America 106: 3189-3200.

D’Spain, G. D., A. D‘Amico, and D. M. Fromm. 2006. Properties of the underwater sound fields during some well documented beaked whale mass stranding events. Journal of Cetacean Research and Management 7:223 -238.

Donovan, G. P. 1984. Blue whales off Peru, December 1982, with special reference to pygmy blue whales. Reports of the International Whaling Commission 34: 473-476.

Donovan, G.P. 1991. A review of IWC stock boundaries. Reports of the International Whaling Commission, Special Issue 13:39- 68.

Drouot, V., A. Gannier and J.C. Goold. 2004. Summer social distribution of sperm whales (*Physeter macrocephalus*) in the Mediterranean Sea. Journal of the Marine Biological Association of the UK 84(3): 6.

Drouot, V., M. Berube, A. Gannier, J.C. Goold, R.J. Reid and P.J. Palsboll. 2004. A note on genetic isolation of Mediterranean sperm whales (Physeter macrocephalus) suggested by mitochondrial DNA. Journal of Cetacean Research and Management 6(1): 29 - 32.

Dufault, S. and H. Whitehead. 1995. An encounter with recently wounded sperm whales (Physeter macrocephalus). Marine Mammal Science 11(4): 4.

Edds, P. L. 1988. Characteristics of finback *Balaenoptera physalus* vocalizations in the St. Lawrence Estuary. Bioacoustics 1: 131-149.

Edds, P.L. 1982. Vocalizations of the blue whale *Balaenoptera musculus*, in the St. Lawrence River. Journal of Mammalogy 63(2):345-347.

Edds, P.L. and J.A.F. MacFarlane. 1987. Occurrence and general behavior of balaenopterid cetaceans summering in the St. Lawrence Estuary, Canada. Canadian Journal of Zoology 65(6):1363-1376.

Edds-Walton, P.L. 1997. Acoustic communication signals of mysticete whales. Bioacoustics 8: 47-60.

Erbe, C. 2000. Detection of whale calls in noise: Performance comparison between a beluga whale, human listeners and a neural network. Journal of the Acoustical Society of America108:297-303.

European Cetacean Society. 2003. Program for the Seventeenth Annual Conference: Marine Mammals and Sound. Las Palmas De Gran Canaria, Spain; 9 – 13 March 2003.

Evans, K., M. Morrice, M. Hindell and D. Thiele. 2002. Three mass strandings of sperm whales (*Physeter macrocephalus*) in southern Australian waters. Marine Mammal Science 18(3): 22.

Faerber, M.M. and R.W. Baird. 2007. Beaked whale strandings in relation to military exercises: a comparison between the Canary and Hawaiian Islands. Poster presentation. The 21st annual European Cetacean Society conference, 22 - 27 April 2007. San Sebastian, Spain.

Fagan, W.F. and E.E. Holmes. 2006. Quantifying the extinction vortex. Ecology Letters 9: 51 - 60.

Fagan, W.F., E. Meir and J.L. Moore. 1999. Variation thresholds for extinction and their implications for conservation strategies. The American Naturalist 154(5): 510-520.

Fagan, W.F., E. Meir, J. Prendergast, A. Folarin and P. Karieva. 2001. Characterizing population vulnerability for 758 species. Ecology Letters 4(2): 132 - 138.

Fechter, L.D. and B. Pouyatos. 2005. Ototoxicity. Environmental Health Perspective 113(7):A443-444.

Félix, F. 2001. Observed changes of behavior in humpback whales during whalewatching encounters off Ecuador. 14th Biennial Conference on the Biology of Marine Mammals, Vancouver, Canada.

Ferber, D. 2005. Sperm whales bear testimony to worldwide pollution. Science 309(5738): 1166.

Fernandez, A. 2004. Pathological findings in stranded beaked whales during the naval military maneuvers near the Canary Islands. Pages 37-40. European Cetacean Society Newsletter.

Fernandez, A., J. F. Edwards, F. Rodriguez, A. Espinosa de los Monteros, P. Herraez, P. Castro, J. R. Jaber, V. Martin, and M. Arbelo. 2005. ―Gas and fat embolic syndrome‖ involving a mass stranding of beaked whales (Family *Ziphiidae*) exposed to anthropogenic sonar signals. Veterinary Pathology 42:12.

Fernandez, A., M. Arbelo, R. Deaville, I. A. P. Patterson, P. Castro, J. R. Baker, E. Degollada *et al*. 2004. Pathology: Whales, sonar and decompression sickness (reply). Nature 428:n.

Fernandez, A., M. Arbelo, R. Deaville, I. A. P. Patterson, P. Castro, J. R. Baker, E. Degollada, H. M. Ross, P. Herraez, A. M. Pocknell, F. Rodriguez, F. E. Howie, A. Espinosa, R. J. Reid, J. R. Jaber, V. Martin, A. A. Cunningham, and P. D. Jepson. 2004. Beaked whales, sonar and decompression sickness. Nature 428:U1 -

2.

Ferrero, R. C., J. Hodder, and J. Cesarone. 1994. Recent strandings of rough-toothed dolphins (*Steno bredanensis*) on the Oregon and Washington coasts. Marine Mammal Science 10:114-115.

Finneran, J. J. 2003. Whole-lung resonance in a bottlenose dolphin (*Tursiops truncatus*) and white whale (*Delphinapterus leucas*). The Journal of the Acoustical Society of America 114:7.

Finneran, J. J., and M. C. Hastings. 2000. A mathematical analysis of the peripheral auditory system mechanics in the goldfish (*Carassius auratus*). The Journal of the Acoustical Society of America 108:14.

Finneran, J. J., C. E. Schlundt, D. A. Carder, and S. H. Ridgway. 2002. Auditory filter shapes for the bottlenose dolphin (*Tursiops truncatus*) and the white whale (*Delphinapterus leucas*) derived with notched noise. The Journal of the Acoustical Society of America 112:7.

Finneran, J. J., C. E. Schlundt, R. Dear, D. A. Carder, and S. H. Ridgway. 2000. Masked temporary threshold shift (MTTS) in odontocetes after exposure to single underwater impulses from a seismic watergun. The Journal of the Acoustical Society of America 108:2515.

Finneran, J. J., D. A. Carder, C. E. Schlundt, and S. H. Ridgway. 2005. Temporary threshold shift in bottlenose dolphins (*Tursiops truncatus*) exposed to mid-frequency tones. The Journal of the Acoustical Society of America 118:10.

Forney, K. A., M. M. Muto, and J. Baker. 1999. U.S. Pacific marine mammal stock assessment: 1999. U.S. Department of Commerce, NOAA Technical Memorandum NOAA-TM-NMFS-SWFC-282, Southwest Fisheries Science Center; La Jolla, California.

Frankel, A.S. 1994. Acoustic and visual tracking reveals distribution, song variability and social roles of humpback whales in Hawai‘ian waters. Unpublished doctoral dissertation, University of Hawai‘i. University Microfilms, Inc.

Frankel, A.S. and C.W. Clark. 1998. Results of low-frequency playback of M-sequence noise to humpback whales, *Megaptera novaeangliae,* in Hawai‘i. Canadian Journal of Zoology 76:521-535.

Frankel, A.S., and C.W. Clark. 2000. Behavioral responses of humpback whales (*Megaptera novaeangliae*) to fullscale ATOC signals. Journal of the Acoustical Society of America 108(4).

Frankel, A.S., J. Mobley, L. Herman. 1995. Estimation of auditory response thresholds in humpback whales using biologically meaningful sounds. Pages 55-70. In: R.A. Kastelein, J.A. Thomas, P.E. Nachtigall (editors)Sensory Systems of Aquatic Mammals. De Spil Publication, Woerden, Netherlands.

Frid, A. 2003. Dall‘s sheep responses to overflights by helicopter and fixed-wing aircraft. Biological Conservation 110:387-399.

Frid, A., and L. Dill. 2002. Human-caused disturbance stimuli as a form of predation risk. Conservation Ecology 6:1- 11.

Fristrup, K.M., L.T. Hatch, and C.W. Clark. 2003. Variation in humpback whale (*Megaptera novaeangliae*) song length in relation to low-frequency sound broadcasts. Journal of the Acoustical Society of America 113(6): 3411-3424

Fritts, T.H. 1983. Turtles, birds, and mammals in the northern Gulf of Mexico and nearby Atlantic waters. FWS/OBS-82/65. Report prepared for the U.S. Department of the Interior, Fish and Wildlife Service; Washington, D.C.

Gagnon, C. J. and C. W. Clark. 1993. The use of U.S. Navy IUSS passive sonar to monitor the movement of blue whales. Abstracts of the 10th Biennial Conference on the Biology of Marine Mammals, Galveston, Texas. November 1993.

Gambell, R. 1976. World whale stocks. Mammal Review 6 (1): 41-53.

Gambell, R. 1985. Fin whale *Balaenoptera physalus* (Linnaeus, 1758). Pages: 171-192. In: *Handbook of marine mammals. Volume 3: The sirenians and baleen whales*. Edited by S.H. Ridgeway and R.J. Harrison. Academic Press; London, United Kingdom.

Gambell, R. 1985. Sei whale *Balaenoptera borealis* (Lesson, 1828). Pages 193-240. In: S.H. Ridgway and R. Harrison (editors). Handbook of marine mammals. Vol. 3: The sirenians and baleen whales. Adacemic Press; London, United Kingdom.

Garrison, L., S.L. Swartz, A. Martinez, C. Burks and J. Stamates. 2003. A marine mammal assessment survey of the southeast U.S. continental shelf: February - April 2002. NOAA Technical Memorandum NMFS-SEFSC-492. U.S. Department of Commerce, National Oceanic and Atmospheric Administration, National Marine Fisheries Service, Southeast Fisheries Science Center; Miami, Florida.

Gauthier, J and R. Sears. 1999. Behavioral response of four species of balaenopterid whales to biopsy sampling. Marine Mammal Science. 15(1): 85-101.

Gill, J. A., and W. J. Sutherland. 2000. Predicting the consequences of human disturbance from behavioral decisions, Pages 51 - 64 *in* L. M. Gosling, and W. J. Sutherland, eds. Behavior and conservation. Cambridge, United Kingdom, Cambridge University Press.

Gill, J. A., K. Norris, and W. J. Sutherland. 2001. Why behavioral responses may not reflect the population consequences of human disturbance. Biological Conservation 97:265-268.

Gisiner, R. C. 1998. Workshop on the effects of anthropogenic noise in the marine environment. U.S. Navy, Office of Naval Research, Marine Mammal Research Program, Washington, D.C.

Glass, A. H., T. V. N. Cole, M. Garron, R. L. Merrick, and R. M. Pace III. 2008. Mortality and serious injury determinations for baleen whale stocks along the United States eastern seaboard and adjacent Canadian maritimes, 2002-2006. U.S. Department of Commerce, National Oceanic and Atmospheric Administration, National Marine Fisheries Service, Northeast Fisheries Science Center, Woods Hole, Massachusetts.

Goddard, P.C. and D.J. Rugh. 1998. A group of right whales seen in the Bering Sea in July 1996. Marine Mammal Science 14(2):344-349.

Goold, J.C. and S.E. Jones. 1995. Time and frequency domain characteristics of sperm whale clicks. Journal of the Acoustical Society of America 98: 1279-1291.

Goold, J.C., H. Whitehead and R.J. Reid. 2002. North Atlantic sperm whale, *Physeter macrocephalus*, strandings on the coastlines of the British Iles and eastern Canada. The Canadian field-naturalist 116(3): 18.

Gordon, J.C.D. 1987. Behavior and ecology of sperm whales off Sri Lanka. Ph.D. dissertation, University of Cambridge, Cambridge, England.

Gore, M.A., E. Ahmad, Q.M. Ali, R.M. Culloch, S. Hameed, S.A. Hasnain, B. Hussain, S. Kiani, N. Shaik, P.J. Siddiqui and R.F. Ormond. 2007. Sperm whale, *Physeter macrocephalus*, stranding on the Pakistani coast. Journal of the Marine Biological Association of the United Kingdom 87(1): 2.

Gosho, M.E., D.W. Rice, and J.M. Breiwick. 1984. Sperm whale interactions with longline vessels in Alaska waters during 1997. Unpublished report available Alaska Fisheries Science Center; Seattle, Washington.

Gotelli, N. J. 2001, A primer of ecology. Sunderland, Massachusetts, Sinauer Associates, Inc. Government Printing Office. 1987. Endangered fish and wildlife; approaching humpback whales in Hawai‘ian waters. Federal Register 52 (225, 23 Nov.):44912-44915.

Grazette, S., J. A. Horrocks, P. E. Phillip, and C. J. Isaac. 2007. An assessment of the marine turtle fishery in Grenada, West Indies. Oryx **41**:330-336.

Hain, J.H.W., M.J. Ratnaswamy, R.D. Kenney, and H.E. Winn. 1992. The fin whale, *Balaenoptera physalus*, in waters of the northeastern United States continental shelf. Reports of the International Whaling Commission 42: 653-669.

Harris, C. M., editor. 1998. Handbook of acoustical measurements and noise control. Acoustical Society of America, Woodbury, New York.

Hazel, J., I. R. Lawler, H. Marsh, and S. Robson. 2007. Vessel speed increases collision risk for the green turtle *Chelonia mydas*. Endangered Species Research **3**:105-113.

Herman, L. M., C. S. Baker, P. H. Forestell and R. C. Antinoja. 1980. Right whale *Balaena glacialis* - sightings near Hawai'i: a clue to the wintering grounds? 2:271-275.

Hildebrand, J. A. 2004. Impacts of anthropogenic sound on cetaceans. Unpublished paper submitted to the International Whaling Commission Scientific Committee SC/56/E13. International Whaling Commission, Cambridge, United Kingdom.

Hildebrand, J. A. 2005. Annex K: Report of the standing working group on environmental concerns. Appendix 3. Introduction to acoustics. Journal of Cetacean Research and Management 7:284 - 286.

Hill, P.S. and D.P. DeMaster. 1999. Pacific Marine Mammal Stock Assessments, 1999. U.S. Department of Commerce, NOAA Technical Memorandum NMFS-AFSC-110. Alaska Fisheries Science Center; Auke Bay, Alaska.

Hohn, A. A., D. S. Rotstein, C. A. Harms, and B. L. Southall. 2006. Report on marine mammal unusual mortality event UME0501Sp Multispecies mass stranding of pilot whales (*Globicephala macrorhynchus*), minke whale (*Balaenoptera acutiorostrata*), and dwarf sperm whales (*Kogia sima*) in North Carolina on 15 – 16 January 2005. NOAA Technical Memorandum NMFS-SEFSC-537. U.S. Department of Commerce, National Oceanic and Atmospheric Administration, National Marine Fisheries Service, Southeast Fisheries Science Center, Miami, Florida.

Holberton, R. L., B. Helmuth, and J. C. Wingfield. 1996. The corticosterone stress response in gentoo and king penguins during the non-fasting period. The Condor 98:4.

Holt, M.M., V. Veirs and S. Veirs. 2007. Noise effects on the call amplitude of southern resident killer whales (*Orcinus orca*) Poster presented at the International conference on the effects of noise on aquatic life, 13 -17 August 2007. Nyborg, Denmark.

Hood, L. C., P. D. Boersma, and J. C. Wingfield. 1998. The adrenocortical response to stress in incubating magellanic penguins (*Spheniscus magellanicus*). The Auk 115:9.

Horwood, J. 1987. The sei whale: population biology, ecology and management. Croom Helm; Beckenham, Kent, United Kingdom.

Houghton, J.T., Y. Ding, D.J. Griggs, M. Noguer, P.J. van der Linden and D. Ziaos (editors). 2001. Contribution of working group 1 to the Third Assessment Report of the Intergovernmental Panel on Climate Change. Cambridge University Press; Cambridge, United Kingdom.

International Whaling Commission (IWC). 1980. Report of the sub-committee on protected species and aboriginal whaling. Reports of the International Whaling Commission 30:103-111.

International Whaling Commission (IWC). 2005. Annex K. Report of the standing working group on environmental concerns. Journal of Cetacean Research and Management 7 (Supplement):267 - 281.

International Whaling Commission [IWC]. 1998. Report of the workshop on the comprehensive assessment of right whales: a worldwide comparison. International Whaling Commission special workshop held 19-25 March 1998, in Cape Town, South Africa. SC/50/REP 4.

Jahoda, M., C. L. Lafortuna, N. Biassoni, C. Almirante, A. Azzelino, S. Panigada, M. Zanardelli *et al*. 2003. Mediterranean fin whale's (*Balaenoptera physalus*) response to small vessels and biopsy sampling assessed through passive tracking and timing of respiration. Marine Mammal Science 19:15.

Jansen, G. 1998. Chapter 25. Physiological effects of noise. Pages 25.21 - 25.19 in C. M. Harris, editor. Handbook of acoustical measurements and noise control. Acoustical Society of America, Woodbury, New York.

Jaquet, N. 1996. How spatial and temporal scales influence understanding of sperm whale distribution. Mammal Review 26:51.

Jaquet, N., and H. Whitehead. 1996. Scale-dependent correlation of sperm whale distribution with environmental features and productivity in the South Pacific. Marine ecology progress series 135:10.

Jasny, M., J. Reynolds, C. Horowitz, and A. Wetzler. 2005. Sounding the depths II: The rising toll of sonar, shipping and industrial ocean noise on marine life. Natural Resources Defense Council, New York, New York. Jefferson, T.A. and A.J. Schiro. 1997. Distribution of cetaceans in the offshore Gulf of Mexico. Mammal Review 27(1): 27-50.

Jepson, P. D., M. Arbelo, R. Deaville, I. A. P. Patterson, P. Castro, J. R. Baker, E. Degollada *et al*. 2003. Gas-bubble lesions in stranded cetaceans. Nature 425:575-576.

Jepson, P. D., R. Deaville, I. A. P. Patterson, A. M. Pocknell, H. M. Ross, J. R. Baker, F. E. Howie, R. J. Reid, A. Colloff, and A. A. Cunningham. 2005. Acute and chronic gas bubble lesions in cetaceans stranded in the United Kingdom. Veterinary Pathology 42:291-305.

Jessop, T. S., A. D. Tucker, C. J. Limpus, and J. M. Whittier. 2003. Interactions between ecology, demography, capture stress, and profiles of corticosterone and glucose in a free-living population of Australian freshwater crocodiles. General and Comparative Endocrinology 132:10.

Johnson, D. H. 1999. The insignificance of statistical significance testing. The Journal of Wildlife Management 63:763-772.

Johnson, P.A. and B.W. Johnson. 1980. Hawai‘ian monk seal observations on French Frigate Shoals, 1980. U.S. Department of Commerce, NOAA Technical Memorandum NMFS-SWFSC-50. National Marine Fisheries Service, Southwest Fisheries Science Center; La Jolla California.

Jones, D. M., and D. E. Broadbent. 1998. Chapter 24. Human peformance and noise. Pages 24.21 - 24.24 in C. M. Harris, editor. Handbook of acoustical measurements and noise control. Acoustical Society of America, Woodbury, New York.

Kastak, D., R.J. Schusterman, B.L. Southall, and C. Reichmuth. 2000. Underwater temporary threshold shift induced by octave-band noise in three species of pinniped. Journal of the Acoustical Society of America 106(2):1142-1148.

Kasuya, T. 1991. Density dependent growth in North Pacific sperm whales. Marine Mammal Science 7(3):230-257.

Kawakami, T. 1980. A review of sperm whale food. Scientific Report of the Whales Research Institute Tokyo 32:199-218.

Kawamura, A. 1982. Food habits and prey distributions of three rorqual species in the North Pacific Ocean. Scientific Reports of the Whales Research Institute, Tokyo 34:59-91.

Ketten, D. R. 2005. Annex K: Report of the standing working group on environmental concerns. Appendix 4. Marine mammal auditory systems: a summary of audiometric and anatomical data and implications for underwater acoustic impacts. Journal of Cetacean Research and Management 7:286 - 289.

Ketten, D.R. 1994. Functional analyses of whale ears: adaptations for underwater hearing. IEEE Proceedings on Underwater Acoustics 1: 264-270.

Ketten, D.R. 1997. Structure and function in whale ears. Bioacoustics 8: 103-135.

Ketten, D.R. 1998. Marine mammal auditory systems: a summary of audiometric and anatomical data and its implications for underwater acoustic impacts. NOAA Technical Memorandum NOAA-TM-NMFS-SWFSC-256.

Klima, E.F., G.R. Gitschlag, and M.L. Renaud. 1988. Impacts of the explosive removal of offshore petroleum platforms on sea turtles and dolphins. Marine Fisheries Review 50(3) 33-42.

Klinowska, M. 1985. Cetacean live stranding sites relate to geomagnetic topography. Aquatic Mammals 1: 27 - 32.

Klinowska, M. 1986. Cetacean live stranding dates relate to geomagnetic disturbances. Aquatic Mammals 11(3): 109- 119.

Korte, S. M., J. M. Koolhaas, J. C. Wingfield, and B. S. McEwen. 2005. The Darwinian concept of stress: benefits of allostasis and costs of allostatic load and the trade-offs in health and disease. Neuroscience and Biobehavioral Reviews 29:3 - 38.

Krausman, P. R., L. K. Harris, C. L. Blasch, K. K. G. Koenen, and J. Francine. 2004. Effects of military operations on behavior and hearing of endangered Sonoran pronghorn. Wildlife Monographs:1-41.

Kuczaj, S., R. Paulos, J. Ramos, R. Thames, G. Rayborn, G. Ioup and J. Newcomb. 2003. Anthropogenic noise and sperm whale sound production. Las Palmas de Gran Canaria, Canary Islands, Spain.

Lafferty, K. D., and R. D. Holt. 2003. How should environmental stress affect the population dynamics of disease? Ecology Letters 6:654-664.

Lagueux, C.J. 1998. Marine turtle fishery of Caribbean Nicaragua: human use patterns and harvest trends. Doctoral Dissertation, University of Florida; Gainesville, Florida.

Lambertsen, R. H. B. A. Kohn, J. P. Sundberg, and C. D. Buergelt. 1987. Genital papillomatosis in sperm whale bulls. Journal of Wildlife Diseases. 23(3):361-367.

Lambertsen, R.H. 1986. Disease of the common fin whale (*Balaenoptera physalus*): Crassicaudiosis of the urinary system. Journal of Mammalogy 67(2): 353-366.

Landis, C.J. 1965. Research: A new high pressure research animal? Undersea Technology 6:21.

Landis, W. G., G.B. Matthews, R.A. Matthews, A. Sergeant. 1994. Application of multivariate techniques to endpoint determination, selection and evaluation in ecological risk assessment. Environmental Toxicology and Chemistry 13: 1917.

Latishev, V.M. 2007. Scientific report from factory ships "Vladivostok" and "Dalniy Vostok" in 1967. Pages: 16-17. In: *Scientific reports of Soviet whaling expeditions in the North Pacific, 1955-1978*. *NOAA Technical Memorandum NMFS-AFSC-175*. Edited by Y.V. Ivashchenko, P.J. Clapham and R.L. Brownell Jr. U.S. Department of Commerce, National Oceanic and Atmospheric Administration, National Marine Fisheries Service, Alaska Fisheries Science Center; Seattle, Washington.

Laurance, W. F., J. M. Fay, R. J. Parnell, G.-P. Sounguet, A. Formia, and M. E. Lee. 2008. Does rainforest logging threaten marine turtles? Oryx **42**:246-251.

Leatherwood, S., R.R. Reeves, W.F. Perrin, and W.E. Evans. 1982. Whales, dolphins, and porpoises of the eastern North Pacific and adjacent arctic waters: a guide to their identification. NOAA Technical Report National Marine Fisheries Service Circular 444.

Lenhardt, M.L. 1994. Auditory behavior of the loggerhead sea turtle (*Caretta caretta*). Page 89. In: K.A. Bjorndahl, A.B. Bolten, D.A. Johnson, and P.J. Eliazar (compilers), Proceedings of the 14th Annual Symposium on Sea Turtle Biology and Conservation. NOAA Technical Memorandum NMFS-SEFC-351.

Lettevall, E., C. Richter, N. Jaquet, E. Slooten, S. Dawson, H. Whitehead, J. Christal and P.M. Howard. 2002. Social structure and residency in aggregations of male sperm whales. Canadian Journal of Zoology 80(7): 8.

Levenson, C. 1974. Source level and bistatic target strength of the sperm whale (*Physeter catodon*) measured from an oceanographic aircraft. Journal of the Acoustical Society of America 55: 1100-1103.

Lipton, J., H. Galbraith, J. Burger, D. Wartenberg. 1993. A paradigm for ecological risk assessment. Environmental Management 17: 1-5.

Ljungblad DK, Clark CW, Shimada H (in press) Sounds attributed to pygmy blue whales (*Balaenoptera musculus brevicauda*) recorded south of the Madagascar Plateau in December 1996 as compared to sounds attributed to "true" blue whales (*Balaenoptera musculus*) recorded off Antarctica in January 1997.

Lombard, E. 1911. Le signe de l'elevation de la voix. Annales Maladies Oreille, Larynx, Nez, Pharynx 37:101-119.

Lockyer, C. 1978. The history and behavior of a solitary wild, but sociable bottlenose dolphin (*Tursiops truncatus*) on the west coast of England and Wales. Journal of Natural History 12:513-528.

Lockyer, C. 1981. Growth and energy budgets of large baleen whales from the Southern Hemisphere. Mammals in the Seas. Vol. 3. Food and Agricultural Organization Fisheries Series 5: 379-487.

Lockyer, C. 1984. Review of baleen whale (Mysticeti) reproduction and implications for management. Reports of the International Whaling Commission, Special Issue 6: 27-50.

Loughlin, T.R., D.J. Rugh, and C.H. Fiscus. 1984. Northern sea lion distribution and abundance: 1956-80. Journal of Wildlife Management 48: 729-740.

Lowell, R.B. J.M. Culp, and M.G. Dube. 2000. A weight of evidence approach to northern river risk assessment: integrating the effects of multiple stressors. Environmental Toxicology and Chemistry 19: 1182-1190.

Lowry, L., D.W. Laist and E. Taylor. 2007. Endangered, threatened, and depleted marine mammals in U.S. waters. A review of species classification systems and listed species. Report prepared for the Marine Mammal Commission; Bethesda, Maryland.

Lutcavage, M. and J.A. Musick. 1985. Aspects of the biology of sea turtles in Virginia. Copeia 1985: 449-456.

Lutcavage, M.E., P. Plotkin, B. Witherington, and P.L. Lutz. 1997. Human impacts on sea turtle survival. Pages 387-409 *in* P.L. Lutz and J.A. Musick, eds. The biology of sea turtles. CRC Press; Boca Raton, Florida.

MacArthur, R.A., R.H. Johnson and V. Geist. 1979. Factors influencing heart rate in free-ranging bighorn sheep: A physiological approach to the study of wildlife harassment. Canadian Journal of Zoology 57(10):2010-

2021.

Mackintosh, N.A. 1942. The southern stocks of whalebone whales. Discovery Reports 22:197-300.

Mackintosh, N.A. 1965. The stocks of whales. Fishing News (Books) Ltd., London.

Mackintosh, N.A. and J.F.G. Wheeler. 1929. Southern blue and fin whales. Discovery Reports 1: 257-540.

MacLeod, C. D., and A. D'Amico. 2006. A review of beaked whale behavior and ecology in relation to assessing and mitigating impacts of anthropogenic noise. Journal of Cetacean Research and Management **7**:211 - 221.

MacLeod, C. D., G. J. Pierce, and M. B. Santos. 2004. Geographic and temporal variations in strandings of beaked whales (Ziphiidae) on the coasts of the UK and the Republic of Ireland from 1800-2002. Journal of Cetacean Research and Management **6**:79 - 86.

Madsen, P.T. and B. Mohl. 2000. Sperm whales (*Physeter catodon* L 1758) do not react to sounds from detonators. The Journal of the Acoustical Society of America 107: 668-671.

Magalhaes, S., R. Prieto, M. A. Silva, J. Goncalves, M. Afonso-Dias, and R. S. Santos. 2002. Short-term reactions of sperm whales (*Physeter macrocephalus*) to whale-watching vessels in the Azores. Aquatic Mammals 28:267-274.

Malme, C. I., P. R. Miles, C. W. Clark, P. Tyack, and J. E. Bird. 1983. Investigations of the potential effects of underwater noise from petroleum industry activities on migrating gray whale behavior: Final Report for the Period of 7 June 1982 - 31 July 1983. Prepared for U.S. Department of the Interior Minerals Management Service, Alaska OCS Office by Bolt Beranek and Newman Inc. Cambridge: Bolt Beranek and Newman Inc., 1983.

Malme, C.I., P.R. Miles, C.W. Clark, P. Tyack, and J. E. Bird. 1984. Investigations of the potential effects of underwater noise from petroleum industry activities on migrating gray whale behavior/Phase II: January 1984 migration. BBN Rep. 586. Rep. from Bolt, Beranek, & Newman, Inc. Cambridge, Massachusetts, for U.S. Minerals Management Service, Anchorage, Alaska.

Malme, C.I., P.R. Miles, P. Tyack, C.W. Clark, and J.E. Bird. 1985. Investigation of the potential effects of underwater noise from petroleum industry activities on feeding humpback whale behavior. Report No. 5851, Unpublished report prepared by Bolt, Beranek and Newman Inc., Cambridge, USA, for U.S. Minerals Management Service, Alaska OCS Office, Anchorage, Alaska.

Marcoux, M., L. Rendell and H. Whitehead. 2007. Indications of fitness differences among vocal clans of sperm whales. Behavioral Ecology and Sociobiology 61(7): 1093-1098.

Marshall, G. J. 1998. Crittercam: an animal-borne imaging and data logging system. Marine Technology Science Journal. 32(1):11-17.

Masaki, Y. 1976. Biological studies on the North Pacific sei whale. Bulletin of the Far Seas Fisheries Research Laboratory (Shimizu) 14:1-104.

Masaki, Y. 1977. The separation of the stock units of sei whales in the North Pacific. Reports of the International Whaling Commission Special Issue No. 1: 71-79.

Masaki, Y. 1980. On the pregnancy rate of the North Pacific sperm whales. Reports of the International Whaling Commission Special Issue 2: 43-48.

Mate, B., K.M. Stafford and D.K. Ljungblad. 1994. A change in sperm whale (*Physeter macrocephalus*) distribution correlated to seismic surveys in the Gulf of Mexico. Journal of the Acoustic Society of America 96: 3268-3269.

Maury, M.F. 1852. Whale chart of the world, (The wind and current charts), Series F, Washington, D.C.

Maury, M.F. 1853. A chart showing the favorite reports of the sperm and right whales by M.F. Maury, L.L.D. Lieutenant, U.S. Navy. Constructed from Maury's whale chart of the world by Robert H. Wayman, Lieutenant, U.S. Navy by Authority of the Commo. Bureau of Ordinance and Hydrography; Washington, D.C.

Maybaum, H.L. 1989. Effects of 3.3 kHz sonar system on humpback whales *Megaptera novaeangliae*, in Hawai'ian waters. Eos.71(2):92.

Maybaum, H.L. 1993. Responses of humpback whales to sonar sounds. The Journal of the Acoustical Society of America 94(3):1848-1849.

Mayo, C.A., and M. K. Marx. 1990. Surface foraging behavior of the North Atlantic right whale (*Eubalaena glacialis*) and associated zooplankton characteristics. Canadian Journal of Zoology 68: 2214-2220.

McArdle, B.H. 1990. When are rare species not there? Oikos 57:276-277.

McCall Howard, M.P. 1999. Sperm whales *Physeter macrocephalus* in the Gully, Nova Scotia: Population, distribution, and response to seismic surveying. Unpublished Thesis prepared for a Batchelor of Science Degree. Dalhousie University, Halifax, Nova Scotia.

McCarthy, J.J., O. Canziani, N.A. Leary, D.J. Dokken and K.S. White (editors). 2001. Climate change 2001: Impacts, adaptation, and vulnerability. Contribution of working group II to the Third Assessment Report of the Intergovernmental Panel on Climate Change. Cambridge University Press; Cambridge, United Kingdom

McCarty, L. S., and M. Power. 1997. Environmental risk assessment within a decision-making framework. Environmental Toxicology and Chemistry 16:122.

McCauley, R. D., and D. H. Cato. 2001. The underwater noise of vessels in the Hervey Bay (Queensland) whale watch fleet and its impact on humpback whales. Journal of the Acoustical Society of America 109:2455.

McCauley, R.D., J. Fewtrell, A.J. Duncan, C. Jenner, M-N Jenner, J.D. Penrose, R.I.T. Prince, A. Adhitya, J. Murdoch, and K. McCabe. 2000. Marine seismic surveys: analysis and propagation of air-gun signals; and effects of air-gun exposure on humpback whales, sea turtles, fishes and squid. Report R99-15. Centre for Marine Science and Technology, Curtin University of Technology, Western Australia.

McDonald, M. A., J. A. Hildebrand, and S. C. Webb. 1995. Blue and fin whales observed on a seafloor array in the northeast Pacific. Journal of the Acoustical Society of America 98:712-721.

McDonald, M.A. and Fox, C.G. 1999. Passive acoustic methods applied to fin whale population density estimation. Journal of the Acoustical Society of America 105(5): 2643-2651

McEwen, B. S., and J. C. Wingfield. 2003. The concept of allostasis in biology and biomedicine. Hormones and Behavior 43:2 - 15.

McEwen, B. S., and T. Seeman. 2000. Overview - protective and damaging effects of mediators of stress: elaborating and testing the concepts of allostasis and allostatic load. Annals of the New York Academy of Sciences 896:18.

Meredith, G.N. and R.R. Campbell. 1988. Status of the fin whale, *Balaenoptera physalus*, in Canada. Canadian Field-Naturalist 102: 351-368.

Metcalf, J., K. Hampson, A. Andriamizava, R. Andrianirina, T. Carines, A. Gray, C. Ramiarisoa, and H. Sondotra. 2007. The importance of north-west Madagascar for marine turtle conservation. Oryx **41**:232-238.

Mikhalven, Y.A. 1997. Humpback whales *Megaptera novaeangliae* in the Arabian Sea. Marine Ecology Progress Series 149:13-21.

Miller, P.J.O., N. Biassoni, A. Samuels and P.L. Tyack. 2000. Whales songs lengthen in response to sonar. Nature 405, 903

Mills, J.H. and J.A. Going. 1982. Review of environmental factors affecting hearing. Environmental Health Perspective 44:119-127.

Mills, S. K., and J. H. Beatty. 1979. The propensity interpretation of fitness. Philosophy of Science 46:263-286.

Mizroch, S.A., D.W. Rice, and J.M. Breiwick. 1984. The blue whale, *Balaenoptera musculus*. Marine Fisheries Review 46(4):15-19.

Mizroch, S.A., D.W. Rice, and J.M. Breiwick. 1984b. The fin whale, *Balaenoptera physalu*s. Marine Fisheries Review 46(4):20-24.

Mizue, K. 1951. Food of whales (in the adjacent waters of Japan). Scientific Reports of the Whales Research Institute 5:81-90.

Moberg, G. P. 1985. Biological response to stress: key to assessment of animal well-being? Pages 27 - 49 in G. P. Moberg, editor. Animal stress. American Physiological Society, Bethesda, Maryland.

Moberg, G. P. 2000. Biological response to stress: implications for animal welfare. Pages 1 - 21 in G. P. Moberg, and J. A. Mench, editors. The biology of animal stress. Basic principles and implications for animal welfare. Oxford University Press, Oxford, United Kingdom.

Mobley, J. R., L. M. Herman, A. S. Frankel. 1988. Responses of wintering Humpback whales (*Megaptera novaeangliae*) to playback of recordings of winter and summer vocalizations and of synthetic sounds. Behavioral Ecology and Sociobiology 23: 211-223

Mobley, J. R., M. Smultea, T. Norris, and D. Weller. 1996. Fin whale sighting north of Kauai, Hawai'i. Pacific Science 50: 230-233.

Mobley, J. R., R. A. Grotefendt, P. H. Forestell, and A. S. Frankel. 1999a. Results of Aerial surveys of marine mammals in the major Hawai'ian Islands (1993-1998): Report to the Acoustic Thermometry of Ocean Climate Marine Mammal Research Program. Cornell University Bioacoustics Research Program, Ithaca, New York.

Mohl, B. 2001. Sound transmission in the nose of the sperm whale *Physeter catodon*. A post mortem study. Journal of Comparative Physiology A Sensory Neural and Behavioral Physiology 187:335-340.

Mohl, B., M. Wahlberg, P. T. Madsen, A. Heerfordt, and A. Lund. 2003. The monopulsed nature of sperm whale clicks. The Journal of the Acoustical Society of America 114:12.

Mohl, B., M. Wahlberg, P. T. Madsen, L. A. Miller, and A. Surlykke. 2000. Sperm whale clicks: Directionality and source level revisited. Journal of the Acoustical Society of America 107:638.

Mohl, *et al*. 2000. Sperm whale clicks: Directionality and source level revisted. Journal of the Acoustical Society of America 107 (1), January 2000, pp. 638 -645.

Mooney, T. A., P. E. Nachtigall, M. Breese, S. Vlachos, and W. W. L. Au. 2009. Predicting temporary threshold shifts in a bottlenose dolphin (*Tursiops truncatus*): The effects of noise level and duration. The Journal of the Acoustical Society of America **125**:1816-1826.

Mooney, T. A., P. E. Nachtigall, and S. Vlachos. 2008. Intense sonar pings induce temporary threshold shift in a bottlenose dolphin (*Tursiops truncatus*). The Journal of the Acoustical Society of America 123:3618.

Moore, J.C. 1953. Distribution of marine mammals in Florida waters. American Midland Naturalist 49(1): 117-158.

Moore, K. E., W. A. Watkins, and P. L. Tyack. 1993. Pattern similarity in shared codas from sperm whales (*Physeter catodon*). Marine Mammal Science 9:1-9.

Morton, A.B. and H.K. Symonds. 2002. Displacement of *Orcinus orca* (L) by high amplitude sound in British Columbia, Canada. ICES Journal of Marine Science 59(1): 71-80.

Mullin, K.D. and G.L. Fulling. 2007. Abundance of cetaceans in the southern U.S. North Atlantic Ocean during summer 1998. Fisheries Bulletin 101:603-613.

Mullins, J., H. Whitehead, and L.S. Weilgart. 1988. Behavior and vocalizations of two single sperm whales, Physeter macrocephalus off Nova Scotia. Canadian Journal of Fisheries and Aquatic Sciences 45(10):1736-1743.

Myrberg, A.A., Jr. 1978. Ocean noise and behavior of marine animals: Relationships and implications. Pages 169-208. In: J.L. Fletcher and R.G. Busnel (eds.) Effects of Noise on Wildlife. Academic Press; New York, New York.

Nachtigall, P. E., A. Y. Supin, J. Pawloski, and W. W. L. Au. 2004. Temporary threshold shifts after noise exposure in the bottlenose dolphin (*Tursiops truncatus*) measured using evoked auditory potentials. Marine Mammal Science 20:15.

Nachtigall, P. E., J. L. Pawloski, and W. W. L. Au. 2003. Temporary threshold shifts and recovery following noise exposure in the Atlantic bottlenosed dolphin (*Tursiops truncatus*). The Journal of the Acoustical Society of America 113:5.

Nachtigall, P. E., M. M. L. Yuen, T. A. Mooney, and K. A. Taylor. 2005. Hearing measurements from a stranded infant Risso‘s dolphin, *Grampus griseus*. The Journal of Experimental Biology 208:4181.

Nasu, K. 1974. Movement of baleen whales in relation to hydrographic conditions in the northern part of the North Pacific Ocean and the Bering Sea. Pages 345-361 *in* D.W. Hood and E.J. Kelley (eds.), Oceanography of the Bering Sea. Institute of Marine Science, University of Alaska; Fairbanks, Alaska.

National Marine Fisheries Service (NMFS). 1992. Environmental assessment of the effects of biopsy darting and associated approaches on humpback whales (*Megaptera novaeangliae*) and right whales (*Eubalaena glacialis*) in the North Atlantic. U.S. Department of Commerce, National Oceanic and Atmospheric Administration, National Marine Fisheries Service, Office of Protected Resources; Silver Spring, Maryland.

National Marine Fisheries Service [NMFS]. 1994. An assessment of whale watching in the United States. Prepared for the International Whaling Commission by U.S. Department of Commerce, U.S. Department of Commerce,

National Oceanic and Atmospheric Administration, National Marine Fisheries Service, Office of Protected Resources; Silver Spring, Maryland.

National Marine Fisheries Service [NMFS]. 1997. Biological opinion on U.S. Navy activities off the southeastern United States along the Atlantic coast. U.S. Department of Commerce, National Oceanic and Atmospheric Administration, National Marine Fisheries Service, Southeast Regional Office; St. Petersburg, Florida.

National Marine Fisheries Service [NMFS]. 1998a. Recovery plan for the blue whale (*Balaenoptera musculus*). U.S. Department of Commerce, National Oceanic and Atmospheric Administration, National Marine Fisheries Service, Office of Protected Resources; Silver Spring, Maryland.

National Marine Fisheries Service [NMFS]. 1998b. Recovery plan for the fin whale *Balaenoptera physalus*. U.S. Department of Commerce, National Oceanic and Atmospheric Administration, National Marine Fisheries Service, Office of Protected Resources; Silver Spring, Maryland.

National Marine Fisheries Service [NMFS]. 1998c. Turtle Expert Working Group, An Assessment of the Kemp's ridley (*Lepidochelys kempii*) and Loggerhead (*Caretta caretta*) Sea Turtle Populations in the Western North Atlantic. NOAA Technical Memorandum NMFS-SEFSC-409. U.S. Department of Commerce, National Oceanic and Atmospheric Administration, National Marine Fisheries Service, Southeast Fisheries Science Center; Miami, Florida.

National Marine Fisheries Service [NMFS]. 2001. Final biological opinion on the U.S. Navy‘s North Pacific Acoustic Laboratory Sound Source. U.S. Department of Commerce, National Oceanic and Atmospheric Administration, National Marine Fisheries Service, Office of Protected Resources; Silver Spring, Maryland.

National Marine Fisheries Service [NMFS]. 2002. Biological opinion on shrimp trawling in the southeastern United States, under the sea turtle conservation regulations and as managed by the Fishery Management Plans for Shrimp in the south Atlantic and Gulf of Mexico. U.S. Department of Commerce, National Oceanic and Atmospheric Administration, National Marine Fisheries Service, Southeast Regional Office; St. Petersburg, Florida.

National Marine Fisheries Service [NMFS]. 2002. Biological opinion on the U.S. Navy‘s Surveillance Towed Array Sensor System Low Frequency Active Sonar (SURTASS LFA). U.S. Department of Commerce, National Oceanic and Atmospheric Administration, National Marine Fisheries Service, Office of Protected Resources, Endangered Species Division, Silver Spring, Maryland.

National Marine Fisheries Service. 2007. Biological opinion on the U.S. Navy's proposed 2007 USS Truman 07-1 Combined Carrier Strike Group Composite Training Unit/Joint Task Force exercise. U.S. Department of Commerce, National Oceanic and Atmospheric Administration, National Marine Fisheries Service, Office of Protected Resources; Silver Spring, Maryland.

National Marine Fisheries Service [NMFS]. 1997. Biological opinion on U.S. Navy activities off the southeastern United States along the Atlantic coast. U.S. Department of Commerce, National Oceanic and Atmospheric Administration, National Marine Fisheries Service, Southeast Regional Office; St. Petersburg, Florida.

National Marine Fisheries Service [NMFS]. 2007. Biological opinion on the U.S. Navy's proposed 2007 USS Truman 07-1 Combined Carrier Strike Group Composite Training Unit/Joint Task Force exercise. U.S. Department of Commerce, National Oceanic and Atmospheric Administration, National Marine Fisheries Service, Office of Protected Resources; Silver Spring, Maryland.

National Marine Fisheries Service and U.S. Fish and Wildlife Service [NMFS and USFWS]. 1998a. Recovery plan for U.S. Pacific population of the east Pacific green turtle (*Chelonia mydas*). U.S. Department of Commerce, National Oceanic and Atmospheric Administration, National Marine Fisheries Service, Office of Protected Resources and U.S. Department of the Interior, U.S. Fish and Wildlife Service, Pacific Region; Silver Spring, Maryland.

National Marine Fisheries Service and U.S. Fish and Wildlife Service [NMFS and USFWS]. 1998b. Recovery plan for U.S. Pacific population of the hawksbill turtle (*Eretmochelys imbricata*). U.S. Department of Commerce, National Oceanic and Atmospheric Administration, National Marine Fisheries Service, Office of Protected Resources and U.S. Department of the Interior, U.S. Fish and Wildlife Service, Pacific Region; Silver Spring, Maryland.

National Marine Fisheries Service and U.S. Fish and Wildlife Service [NMFS and USFWS]. 1998c. Recovery plan for U.S. Pacific population of the leatherback turtle (*Dermochelys coriacea*). U.S. Department of Commerce, National Oceanic and Atmospheric Administration, National Marine Fisheries Service, Office of Protected Resources and U.S. Department of the Interior, U.S. Fish and Wildlife Service, Pacific Region; Silver Spring, Maryland.

National Marine Fisheries Service and U.S. Fish and Wildlife Service [NMFS and USFWS]. 1998d. Recovery plan for U.S. Pacific population of the loggerhead turtle (*Caretta caretta*). U.S. Department of Commerce, National Oceanic and Atmospheric Administration, National Marine Fisheries Service, Office of Protected Resources and U.S. Department of the Interior, U.S. Fish and Wildlife Service, Pacific Region; Silver Spring, Maryland.

National Marine Fisheries Service and U.S. Fish and Wildlife Service [NMFS and USFWS]. 1998e. Recovery plan for U.S. Pacific population of the olive ridley turtle (*Lepidochelys olivacea*). U.S. Department of Commerce, National Oceanic and Atmospheric Administration, National Marine Fisheries Service, Office of Protected Resources and U.S. Department of the Interior, U.S. Fish and Wildlife Service, Pacific Region; Silver Spring, Maryland.

National Research Council [NRC]. 1994. Low-frequency sound and marine mammals, current knowledge and research needs. National Academy Press; Washington, D.C.

National Research Council [NRC]. 1996. Marine mammals and low frequency sound: Progress since 1994 – an interim report. National Academy Press; Washington, D.C.

National Research Council [NRC]. 2000. Marine mammals and low frequency sound: Progress since 1994. National Academy Press; Washington, D.C.

National Research Council [NRC]. 2003. Ocean noise and marine mammals. National Academy Press; Washington, D.C.

National Research Council 2005. Marine mammal populations and ocean noise : determining when noise causes biologically significant effects. National Academies Press, Washington, D.C.

Nemoto T. 1964. School of baleen whales in the feeding areas. Scientific Reports of the Whales Research Institute 18: 89-110.

Nemoto, T. 1957. Foods of baleen whales in the northern Pacific. Scientific Reports of the Whales Research Institute 12:33-89.

Nemoto, T. 1970. Feeding pattern of baleen whales in the oceans. Pages 241-252 *in* Steele, J.H. (ed.), Marine Food Chains. University of California Press, Berkeley, California.

Nemoto, T. 1978. Humpback whales observed within the continental shelf waters of the Bering Sea. Scientific Reports of the Whales Research Institute, Tokyo 39:245-247.

Nemoto, T., and A. Kawamura. 1977. Characteristics of food habits and distribution of baleen whales with special reference to the abundance of North Pacific sei and Bryde‘s whales. Reports of the International Whaling Commission, Special Issue 1:80-87.

Newman, M. C., D. R. Ownby, L. C. A. Mezin, D. C. Powell, T. R. L. Christensen, S. B. Lerberg, and B. A. Anderson. 2000. Applying species-sensitivity distributions in ecological risk assessment: assumptions of distribution type and sufficient numbers of species. Environmental Toxicology and Chemistry 19:508.

Nishiwaki, M. 1952. On the age determination of Mystacoceti, chiefly blue and fin whales. Scientific Reports of the Whales Research Institute 7: 87-119.

Nishiwaki, M. 1966. Distribution and migration of the larger cetaceans in the North Pacific as shown by Japanese whaling results. Pages 171-191 *in* Norris, K.S., (ed.), Whales, Dolphins and Porpoises. University of California Press, Berkeley.

Nitta, E.T. 1991. The marine mammal stranding network for Hawaii, an overview. U.S. Department of Commerce, National Oceanic and Atmospheric Administration, National Marine Fisheries Service, Office of Protected Resources; Silver Spring, Maryland.

Norrgard, J. 1995. Determination of stock composition and natal origin of a juvenile loggerhead turtle population (*Caretta caretta*) in Chesapeake Bay using mitochondrial DNA analysis. Thesis prepared in partial fulfillment of a Master's Degree in Arts. College of William and Mary; Williamsburg, Virginia.

Norris, T.F. 1994. Effects of boat noise on the acoustic behavior of humpback whales. The Journal of the Acoustical Society of America 96(1):3251.

Norton, S. B., D. J. Rodier, J. H. Gentile, W. H. Van Der Schalie, and W. P. Wood. 1992. The framework for ecological risk assessment at the EPA. Environmental Toxicology and Chemistry 11:1663.

Notarbartolo-di-Sciara, G., M. Zanardelli, M. Jahoda, S. Panigada, and S. Airoldi. 2003. The fin whale *Balaenoptera physalus* (L. 1758) in the Mediterranean Sea. Mammal Review 33:105-150.

Nowacek, D., M. P. Johnson and P.L. Tyack. 2004. North Atlantic right whales (*Eubalaena glacialis*) ignore ships but respond to alerting stimuli. Proceedings of the Royal Society of London. Series B. Biological Sciences 271: 227-231.

O‘Hara, J. and J.R. Wilcox. 1990. Avoidance responses of loggerhead turtles, *Caretta caretta*, to low frequency sound. Copeia 1990:564-567.

O’Hara, T.M., M.M. Krahn, D. Boyd, P.R. Becker, and L.M. Philo. 1999. Organochlorine contaminant levels in Eskimo harvested bowhead whales of arctic Alaska. Journal of Wildlife Diseases 35(4): 741-52.

O’Shea, T.J. and R.L.J. Brownell. 1994. Organochlorine and metal contaminants in baleen whales: A review and evaluation of conservation implications. Science of the Total Environment 154 (2-3): 179-200.

Ohsumi, S. 1980. Catches of sperm whales by modern whaling in the North Pacific. Reports of the International Whaling Commission Special Issue 2: 11-18.

Ohsumi, S. 1980. Criticism of Japanese fishing effort for sperm whales in the North Pacific. Reports of the International Whaling Commission Special Issue 2: 19-30.

Ohsumi, S. 1980. Population assessment of the sperm whale in the North Pacific. Reports of the International Whaling Commission Special Issue 2: 31-42.

Ohsumi, S., and S. Wada. 1974. Status of whale stocks in the North Pacific, 1972. Reports of the International Whaling Commission 24:114-126.

Palumbi, S.R. and J. Roman. 2006. The history of whales read from DNA. Pages: 102-115. In: *Whales, whaling, and ocean ecosystems*. Edited by J.A. Estes, D.P. DeMaster, D.F. Doak, T.M. Williams and R.L. Brownell Jr. University of California Press; Berkeley and Los Angeles, California.

Parks, S.E. and C.W. Clark. 2007. Short- and long-term changes in right whale calling behavior: the potential effects of noise on acoustic communication. Journal of the Acoustic Society of America 122(6): 3725-3731.

Patricelli, G.L. and J.L. Blickley. 2006. Avian communication in urban noise: causes and consequences of vocal adjustment. The Auk 123(3):639-649.

Patterson, B. and G. R. Hamilton. 1964. Repetitive 20 cycle per second biological hydroacoustic signals at Bermuda. In: Tavolga, W.N. (ed.) Marine bioacoustics.

Payne, R. and D. Webb. 1971. Orientation by means of long range acoustic signaling in baleen whales. Annals of the New York Academy of Sciences 188:0110-141.

Parry, M., O. Canziani, J. Palutikof and P.J. van der Linden (editors). 2007. Climate change 2001: Impacts, adaptation, and vulnerability. Contribution of working group II to the Third Assessment Report of the Intergovernmental Panel on Climate Change. Cambridge University Press; Cambridge, United Kingdom

Perry, S.L., D.P. DeMaster, and G.K. Silber. 1999. The great whales: history and status of six species listed as endangered under the U.S. Endangered Species Act of 1973. Marine Fisheries Review 61: 1-74.

Piantadosi, C. A., and E. D. Thalmann. 2004. Pathology: Whales, sonar and decompression sickness. Nature 428:n.

Piatt, J. F. and D. A. Methven. 1992. Threshold foraging behavior of baleen whales. Marine Ecology Progress Series 84:205-210.

Piatt, J. F., D. A. Methven, A. E. Burger, R. L. McLagan, V. Mercer and E. Creelman. 1989. Baleen whales and their prey in a coastal environment. Canadian Journal of Zoology 67:1523-1530.

Plotkin, P. and A.F. Amos. 1988. Entanglement in and ingestion of marine debris by sea turtles by sea turtles stranded along the south Texas coast. The Eighth Annual Workshop on Sea Turtle Conservation and Biology, Fort Fisher, North Carolina.

Plotkin, P. and A.F. Amos. 1990. Effects of anthropogenic debris on sea turtles in the northwestern Gulf of Mexico. Pages 736-743 *in* R.S. Shomura and M.L. Godfrey (editors). Proceedings of the Second International Conference on Marine Debris. NOAA Technical Memorandum NMFS- SWFSC-154. Southwest Fisheries Science Center, LaJolla, California.

Plotkin, P.T., M.K. Wicksten, and A.F. Amos. 1993. Feeding ecology of the loggerhead sea turtle, *Caretta caretta*, in the Northwestern Gulf of Mexico. Marine Biology 115: 1-15.

Polmar, N. 2001. The Naval Institute guide to the ships and aircraft of the U.S. fleet. Naval Institute Press; Annapolis, Maryland.

Posner, M.I. 1994. Attention: the mechanism of consciousness. Proceedings of the National Academy of Science of the United States of America 91:7398-7403.

Potter, J.R. 2004. A possible mechanism for acoustic triggering of decompression sickness symptoms in deep-diving marine mammals. Underwater Technology April 2004: 20-23.

Prevalichin, V.I. 2007. Scientific report for "Dalniy Vostok" and "Vladivostok" for the 1973 season. Pages: 20-22. In: *Scientific reports of Soviet whaling expeditions in the North Pacific, 1955-1978*. *NOAA Technical Memorandum NMFS-AFSC-175*. Edited by Y.V. Ivashchenko, P.J. Clapham and R.L. Brownell Jr. U.S. Department of Commerce, National Oceanic and Atmospheric Administration, National Marine Fisheries Service, Alaska Fisheries Science Center; Seattle, Washington.

Pritchard, P.C.H. 1969. Endangered species: Kemp's ridley turtle. Florida Naturalist, 49:15-19.

Pryor, K. 1990. Non-acoustic communication in small cetaceans: glance, touch, position, gesture, and bubbles. In:J.A. Thomas and R.A. Kastelein (eds.), Sensory Abilities in Cetaceans - Laboratory and Field Evidence. p.537-544. NATO ASI Series, Plenum Press, New York.

Rankin-Baransky, K.C. 1997. Origin of loggerhead turtles (*Caretta caretta*) in the western North Atlantic as determined by mt DNA analysis. Thesis prepared in partial fulfillment of a Master's Degree in Science. Drexel University; Philadelphia, Pennsylvania

Ray, G. C., E. Mitchell, D. Wartzok, V. Koxicki, and R. Maiefski. 1978. Radio tracking of a fin whale (*Balaenoptera physalus*). Science 202: 521-524.

Rees, A. F., A. Saad, and M. Jony. 2008. Discovery of a regionally important green turtle *Chelonia mydas* rookery in Syria. Oryx **42**:456-459.

Reeves, R. R. 1992. Whale responses to anthropogenic sounds: a literature review. New Zealand Department of Conservation, Wellington, New Zealand.

Reeves, R.R. and H. Whitehead. 1997. Status of the sperm whale, *Physeter macrocephalus*, in Canada. The Canadian Field-Naturalist 111(2): 293-307.

Reeves, R.R., B.D. Smith, E.A. Crespo, G. Notarbartolo di Sciara. 2002. Dolphins, whales and porpoises. 2002 –2010 Conservation action plan for the world's cetaceans. The World Conservation Union, Cetacean Specialist Group. IUCN; Gland, Switzerland and Cambridge, United Kingdom.

Relyea, R. A. 2003. Predator cues and pesticides: A double dose of danger for amphibians. Ecological Applications 13:7.

Relyea, R. A. 2005. The lethal impacts of roundup and predatory stress on six species of North American tadpoles. Archives of Environmental Contamination and Toxicology 48:7.

Relyea, R. A., and N. Mills. 2001. Predator-induced stress makes the pesticide carbaryl more deadly to gray treefrog tadpoles (*Hyla versicolor*). Proceedings of the National Academy of Sciences of the United States of America 98:6.

Rendell, L. and H. Whitehead. 2004. Do sperm whales share coda vocalizations? Insights into coda usage from acoustic size measurement. Animal Behavior 67(5): 10.

Rendell, L. and H. Whitehead. 2005. Coda playbacks to sperm whales in Chilean waters. Marine Mammal Science 21(2): 10.

Rendell, L., H. Whitehead and A. Coakes. 2005. Do breeding male sperm whales show preferences among vocal clans of females? Marine Mammal Science 21(2): 6.

Reneerkens, J., R. I. G. Morrison, M. Ramenofsky, T. Piersma, and J. C. Wingfield. 2002. Baseline and stress induced levels of corticosterone during different life cycle substages in a shorebird on the high arctic breeding grounds. Physiological and Biochemical Zoology 75:200-208.

Rice, D.W. 1974. Whales and whale research in the eastern North Pacific . Pages 170-195 *in* Schevill, W.E. (ed.), The Whale Problem: A Status Report. Harvard University Press, Cambridge, Massachusetts.

Rice, D.W. 1977. Synopsis of biological data on the sei whale and Bryde‘s whale in the eastern North Pacific. Reports of the International Whaling Commission, Special Issue No. 1:92-97.

Rice, D.W. 1986. Sperm whales. Pages 94-101 *in* D. Haley (ed.), Marine Mammals of the Eastern North pacific and Arctic Waters, 2nd ed. Pacific Search Press, Seattle, Washington.

Rice, D.W. 1989. Sperm whale, *Physeter macrocephalus* (Linneaus, 1758). In: *Handbook of marine mammals. Volume 4. River dolphins and the larger toothed whales*. Edited by S.H. Ridgeway and R.J. Harrison. Academic Press, Inc.; New York, New York.

Richard, K.R., M.C. Dillon, H. Whitehead and J.M. Wright. 1996. Patterns of kinship in groups of free-living sperm whales (*Physeter macrocephalus*) revealed by multiple molecular genetic analyses. Proceedings of the National Academy of Science of the United States of America 93(16): 8792-8795.

Richardson W.J., C.R. Greene Jr., C.I. Malme, and D.H. Thomson. 1995. Marine mammals and noise. Academic Press; San Diego, California.

Richardson, W. J., C. R National Marine Fisheries Service [NMFS]. 1998b. Recovery plan for the fin whale *Balaenoptera physalus*. Prepared by R.R. Reeves, G.K. Silber, and P. Michael Payne for the U.S. Department of Commerce, National Oceanic and Atmospheric Administration, National Marine Fisheries Service, Office of Protected Resources; Silver Spring, Maryland.

Greene, Jr., C. I. Malme and D. H. Thompson. 1991. Effects of noise on marine mammals. OCS Study MMS-90-0093; LGL Rep. TA834-1. Unpublished report prepared by LGL Ecological Research Associates, Inc. for U.S. Minerals Management Service, Atlantic OCS Reg., Herndon, Virginia. NTIS PB91-168914.

Richardson, W.J., C.R. Greene, Jr., W.R. Koski and M.A. Smultea. 1991a. Acoustic effects of oil production activities on bowhead and white whales visible during spring migration near Pt. Barrow, Alaska – 1990 phase. OCS Study MMS 91-0037; LGL Rep. TA848-5. Unpublished Report prepared by LGL Ltd., for U.S. Minerals Management Service, Herndon, Virginia. NTIS PB92-170430.

Richter, C., S. Dawson and E. Slooten. 2006. Impacts of commercial whale watching on male sperm whales at Kaikoura, New Zealand. Marine Mammal Science 22(1): 18.

Richter, C., S.M. Dawson and E. Slooten. 2003. Sperm whale watching off Kaikoura, New Zealand: effects of current activities on surfacing and vocalization patterns. Science for Conservation 219. New Zealand Department of Conservation; Wellington, New Zealand.

Rivers, J.A. 1997. Blue whale, *Balaenoptera musculus*, vocalizations from the waters off central California. Marine Mammal Science 13(2):10.

Romano, T.A., M.J. Keogh, C. Kelly, P. Feng, L. Berk, C.E. Schlundt, D.A. Carder and J.J. Finneran. 2004. Anthropogenic sound and marine mammal health: measures of the nervous and immune systems before and after intense sound exposure. Canadian Journal of Fisheries and Aquatic Science 61: 1124-1134.

Romero, A., K.T. Hayford and J. Romero. 2002. The marine mammals of Grenada, W.I., and their conservation status. Mammalia 66(4): 479-494.

Romero, L. M. 2004. Physiological stress in ecology: lessons from biomedical research. Trends in Ecology and Evolution 19:249-255.

Romero, L. M., and M. Wikelski. 2001. Corticosterone levels predict survival probabilities of Galapagos marine iguanas during El Nino events. Proceedings of the National Academy of Sciences of the United States of America 98:5.

Romero, L. M., and M. Wikelski. 2002. Exposure to tourism reduces stress-induced corticosterone levels in Galapagos marine iguanas. Biological conservation 108:371-374.

Salden, D.R. 1988. Humpback whale encounter rates offshore at Maui, Hawaii. The Journal of Wildlife Management 52(2): 301-304.

Sapolsky, R. M., L. M. Romero, and A. U. Munck. 2000. How do glucocorticoids influence stress responses? Integrating permissive, suppressive, stimulatory, and preparative actions. Endocrine Reviews 21:55 – 89.

Schmidly, D.J. 1981. Marine mammals of the southeastern United States coast and the Gulf of Mexico. Biological Services Program FWS.OBS-80/41. U.S. Department of the Interior, Bureau of Land Management and U.S. Fish and Wildlife Service; Slidell, Louisiana.

Scott, T.M. and S. Sadove. 1997. Sperm whale, *Physeter macrocephalus*, sightings in the shallow shelf waters off Long Island, New York. Marine Mammal Science 13(2): 4.

Sears, C.J. 1994. Preliminary genetic analysis of the population structure of Georgia loggerhead sea turtles. NOAA Technical Memorandum NMFS-SEFSC-351. U.S. Department of Commerce, National Oceanic and Atmospheric Administration, National Marine Fisheries Service, Southeast Fisheries Science Center; Miami, Florida.

Sears, C.J., B.W. Bowen, R.W. Chapman, S.B. Galloway, S.R. Hopkins-Murphy and C.M. Woodley. 1995. Demographic composition of the feeding population of juvenile loggerhead sea turtles (*Caretta caretta*) off Charleston, South Carolina: evidence from mitochondrial DNA markers. Marine Biology 123:869-874.

Sergeant, D. E. 1977. Stocks of fin whales, *Balaenoptera physalus*, in the North Atlantic Ocean. Reports of the International Whaling Commission 27: 460-473.

Shane, S.H., R.S. Wells, and B. Wursig. 1986. Ecology, behavior and social organization of the bottlenose dolphin: A review. Marine Mammal Science 2(1):34-63.

Sharpe F.A., L.M. Dill. 1997. The behavior of Pacific herring schools in response to artificial humpback whale bubbles. Canadian Journal of Zoology 75: 725-730

Sigurjonsson, J. and T. Gunnlaugsson. 1990. Recent trends in abundance of blue whales (*Balaenoptera musculus*) and humpback whales (*Megaptera novaeangliae*) off west and southwest Iceland with a note on occurrence of other cetacean species. Report of the International Whaling Commission 40: 557-551.

Sih, A., A. M. Bell, and J. L. Kerby. 2004. Two stressors are far deadlier than one. Trends in Ecology and Evolution 19:274-276.

Silber, G. K. 1986. The relationship of social vocalizations to surface behavior and aggression in the Hawai'ian humpback whale (*Megaptera novaeangliae*). Canadian Journal of Zoology 64:2075-2080.

Slabbekoorn, H. and M. Peet. 2003. Birds sing at a higher pitch in urban noise: Great Tits hit the high notes to ensure that their mating calls are heard above the city's din. Nature 424:267.

Sleptsov, M.M. 1955. Biology of whales and the whaling fishery in Far Eastern seas. >Pishch. Prom.‘, Moscow [In Russian] (Translated with comments and conclusions only by Fisheries Research Board of Canada Translation Series 118, 6 pp.)

Slijper E. 1962. Whales. Basic Books; New York, New York.

Smith, S.C. and H. Whitehead. 1993. Variations in the feeding success and behavior of Galapagos sperm whales (Physeter macrocephalus) as they relate to oceanographic conditions. Canadian Journal of Zoology 71(10):1991-1996.

Smith, S.C. and H. Whitehead. 2000. The diet of Galapagos sperm whales *Physeter macrocephalus* as indicated by fecal sample analysis. Marine Mammal Science 16(2): 11.

Smultea, M.A. 1989. Habitat utilization patterns of humpback whales off West Hawai‘i. Unpublished report prepared for the Marine Mammal Commission, Contract No. T6223925-9. Bethesda, Maryland.

Sonobuoy Tech Systems. No date. AN/SSQ-63E DICASS sonobuoy. Brochure of specifications. Columbia City, Indiana and Deleon Springs, Florida.

Southall, B.L. 2007. Mid-frequency active sonar - marine mammal behavioral response functions. Scientific peer review process - December 2007. Memorandum to Mr. James Lecky, Director, Office of Protected Resources. U.S. Department of Commerce, National Oceanic and Atmospheric Administration, National Marine Fisheries Service; Silver Spring, Maryland.

Southall, B. L., R. Braun, F. M. D. Gulland, A. D. Heard, R. W. Baird, S. M. Wilkin, and T. K. Rowles. 2006. Hawai’ian melon-headed whale (*Peponacephala electra*) mass stranding event of July 3 - 4, 2004. NOAA Technical Memorandum NMFS-OPR-31. U.S. Department of Commerce, National Oceanic and Atmospheric Administration, National Marine Fisheries Service, Silver Spring, Maryland.

Southall, B. L., R. J. Schusterman, and D. Kastak. 2000. Masking in three pinnipeds: Underwater, low-frequency critical ratios. Journal of the Acoustical Society of America 108:1322.

Spaulding, G.C. 1964. Comparative feeding habits of the fur seal, sea lion, and harbour seal on the British Columbia coast. Fisheries Research Board of Canada, Bulletin No. 146.

Spero, D. 1981. Vocalizations and associated behavior of northern right whales *Eubalaena glacialis*. Abstracts of the Fourth Biennial Conference on the Biology of Marine Mammals, San Francisco, USA, December 1981.

St. Aubin, D.J. and J.R. Geraci. 1988. Capture and handling stress suppresses circulating levels of thyroxine (T4) and triiodothyronine (T3) in beluga whales *Delphinapterus leucas*. Physiological Zoology 61(2): 170-175.

Stancyk, S. E. 1982. Non-human predators of sea turtles and their control. Pages 139 – 152, In K. A. Bjorndal (editor). Biology and Conservation of Sea Turtles. Smithsonian Institution Press, Washington, D.C.

Stanley. K.M., E.K. Stabenau, and A.M. Landry. 1988. Debris ingestion by sea turtles along the Texas Coast. Eighth Annual Workshop on Sea Turtle Conservation and Biology, Fort Fisher, North Carolina.

Stark, J. D., J. E. Banks, and R. Vargas. 2004. How risky is risk assessment: The role that life history strategies play in susceptibility of species to stress. Proceedings of the National Academy of Sciences of the United States of America 101:732-736.

Stearns, S. C. 1992. The evolution of life histories. New York, New York, Oxford University Press.

Stone, C.J. 1997. Cetacean observations during seismic surveys in 1996. Joint Nature Conservation Committee, Rep. 228, Aberdeen, Scotland.

Stone, C.J. 1998. Cetacean observations during seismic surveys in 1997. Joint Nature Conservation Committee Rep. 278, Aberdeen, Scotland.

Stone, C.J. 2000. Cetacean observations during seismic surveys in 1998. Joint Nature Conservancy, Aberdeen, Scotland.

Stone, C.J. 2001. Marine mammal observations during seismic surveys in 1999. JNCC Report 316. Joint Nature Conservation Committee Rep. 316, Aberdeen, Scotland.

Stone, C.J. 2003. The effects of seismic activity on marine mammals in UK waters, 1998-2000 JNCC Report No. 323.

Sun, J.W.C. and P.M. Narins. 2005. Anthropogenic sounds differentially affect amphibian call rate. Biological Conservation 121:419-427.

Swift, R. 1998. The effects of array noise on cetacean distribution and behavior. Department of Oceanography. University of Southampton; Southampton, United Kingdom

Taylor, B., J. Barlow, R. Pitman, L. Ballance, T. Klinger, D. DeMaster, J. Hildebrand, J. Urban, D. Palacios, and J Mead. 2004. A call for research to assess risk of acoustic impact on beaked whale populations. Unpublised paper submitted to the International Whaling Commission, Scientific Committee SC/56/E36. Cambridge, United Kingdom.

Thomas, J. A., R. A. Kastelein and F. T. Awbrey. 1990. Behavior and blood catecholamines of captive belugas during playbacks of noise from an oil drilling platform. Zoo Biology 9(5): 393-402.

Thompson P.O., L.T. Findley, O. Vidal, W.C. Cummings. 1996. Underwater sounds of blue whales, *Balaenoptera physalus*, in the Gulf of California, Mexico. Marine Mammal Science 288-293.

Thompson P.O., W.C. Cummings, S.J. Ha. 1986. Sounds, source levels, and associated behavior of humpback whales, southeast Alaska. Journal of the Acoustical Society of America 80: 735-740.

Thompson T. J., H. E. Winn, and P. J. Perkins. 1979. Mysticete sounds. Pages 403-431. In: H.E. Winn and B.L. Olla (editors). Behavior of Marine Animals. Vol. 3. Cetaceans. Plenum Press; New York, New York.

Thompson, P.O. and W.A. Friedl. 1982. A long term study of low frequency sounds from several species of whales off Oahu, Hawai'i. Cetology 45: 1-19.

Thompson, P.O., L.T. Findley, and O. Vidal. 1992. 20-Hz pulses and other vocalizations of fin whales, Balaenoptera physalus, in the Gulf of California, Mexico. Journal of the Acoustical Society of America 92: 3051-3057.

Thomson, C.A. and J.R. Geraci. 1986. Cortisol, aldosterone, and leucocytes in the stress response of bottlenose dolphins, *Tursiops truncatus*. Canadian Journal of Fisheries and Aquatic Sciences 43(5): 1010-1016

Tillman, M.F. 1977. Estimates of population size for the North Pacific sei whale. Reports of the International Whaling Commission Special Issue No. 1:98-106.

Todd S., P. Stevick, J. Lien, F. Marques, D. Ketten. 1996. Behavioral effects of exposure to underwater explosions in humpback whales *Megaptera novaeangliae*. Canadian Journal of Zoology 74: 1661-1672.

Tomich, P.Q. 1986. Mammals in Hawai'i. A synopsis and notational bibliography. Second edition. Bishop Museum Press; Honolulu, Hawai'i.

Tomilin, A. G. 1957. Cetacea. In: Heptner, V. G. (ed.). Mammals of the USSR and adjacent countries. Vol. 9. Israel Program for Scientific Translations, Jerusalem, 1967.

Townsend, C.H. 1935. The distribution of certain whales as shown by logbook records of American whaleships. Zoologica (N.Y.) 19:1-50.

Trimper, P. G., N. M. Standen, L. M. Lye, D. Lemon, T. E. Chubbs, and G. W. Humphries. 1998. Effects of low level jet aircraft noise on the behavior of nesting osprey. The Journal of Applied Ecology 35:9.

Turl, C.W. 1980. Literature review on: I. Underwater noise from offshore oil operations and II. Underwater hearing and sound productions of marine mammals. Naval Ocean Systems Center Report, San Diego, California.

Tyack P. and H. Whitehead. 1983. Male competition in large groups of wintering humpback whales. Behavior 83: 132-154.

Tyack, P.L. 2000. Functional aspects of cetacean communication. Pages 270-307. In: J. Mann, R.C. Connor, P.L. Tyack, and H. Whitehead (eds.) Cetacean societies: field studies of dolphins and whales. The University of Chicago Press; Chicago, Illinois.

Tyack, P.L. and C.W. Clark. 1997. Long range acoustic propagation of whale vocalizations. In: M. Taborsky and B. Taborsky. (editors) Advances in Ethology, 32. pp 28. Contributions to the XXV International Ethological Conference: Vienna, Austria.

U.S. Department of the Navy [Navy]. 2001. Final Environmental Impact Statement for the shock trial of the USS Winston S. Churchill (DDG-81). Department of the Navy, Chief of Naval Operations, Washington, D.C. U.S. Department of the Navy [Navy]. 2006a. Final comprehensive overseas environmental assessment for major Atlantic fleet training exercises. Department of the Navy, Chief of Naval Operations; Washington, D.C.

U.S. Department of the Navy [Navy]. 2006b USS Bataan Expeditionary Strike Group Composite Training Unit Exercise 07-1 (ESG COMPTUEX) After Action Report. Department of the Navy, U.S. Fleet Forces Command, Norfolk, Virginia.

U.S. Department of the Navy [Navy]. 2007a. Draft supplement to the final comprehensive overseas environmental assessment for major Atlantic fleet training exercises. 2008 exercises. Department of the Navy, Chief of Naval Operations; Washington, D.C.

U.S. Department of the Navy [Navy]. 2007b. Draft Environmental Impact Statement and Overseas Environmental Impact Statement (EIS/OEIS): Ship Shock Trial on the Mesa Verde (LPD 19). Department of the Navy, Chief of Naval Operations; Washington, D.C.

U.S. Department of the Navy [Navy]. 2007c. Expeditionary Strike Group Composite Training Unit Exercise 07-02 (ESG COMPTUEX 08-02): after action report for the exercise occurring 11 May to 01 June 2007. U.S. Department of the Navy, Fleet Forces Command, Norfolk, Virginia.

U.S. Department of the Navy [Navy]. 2007d. Navy Oparea density estimates (NODE) for the southeast opareas: Virginia Capes, Cherry Point, Jacksonville-Charleston, and southeastern Florida and AUTEC-Andros. Prepared for the U.S. Department of the Navy by Geo-Marine Inc.; Norfolk, Virginia.

U.S. Department of the Navy [Navy]. 2007e. USS Truman 07-01 Combined Carrier Strike Group Composite Training Unit Exercise/Joint Task Force Exercise (Combined CSG COMPTUEX/JTFEX 07-01): After action report for the exercise occurring 02 July ro 01 August 2007. U.S. Department of the Navy, Fleet Forces Command, Norfolk, Virginia.

U.S. Department of the Navy [Navy]. 2008a. Biological evaluation for three Navy east coast range complexes. Department of the Navy, U.S. Fleet Forces Command, Norfolk, Virginia.

U.S. Department of the Navy [Navy]. 2008b. Final Atlantic Fleet Active Sonar Training Environmental Impact Statement and Overseas Environmental Impact Statement U.S. Department of the Navy, Fleet Forces Command, Norfolk, Virginia.

U.S. Department of the Navy [Navy]. 2008c. USS Iwo Jima Expeditionary Strike Group Composite Training Unit Exercise 08-03 (ESG COMPTUEX 08-03): after action report for the exercise occurring 08 to 31 July 2008. U.S. Department of the Navy, Fleet Forces Command, Norfolk, Virginia.

U.S. Department of the Navy [Navy]. 2008d. USS Nassau Expeditionary Strike Group Composite Training Unit Exercise 08-01 (ESG COMPTUEX 08-01): after action report for the exercise occurring 28 November to 14 December 2007. U.S. Department of the Navy, Fleet Forces Command, Norfolk, Virginia.

U.S. Department of the Navy [Navy]. 2008e. USS Theodore Roosevelt Carrier Strike Group Composite Training Unit Exercise 08-02 (CSG COMPTUEX 08-02): after action report for the exercise occurring 24 April to 16 May 2008. U.S. Department of the Navy, Fleet Forces Command, Norfolk, Virginia.

U.S. Department of the Navy [Navy]. 2009a. February 2009 addendum to Biological Evaluation for three Navy East Coast Range Complexes: Virginia Capes Range Complex, Navy Cherry Point Range Complex, and Jacksonville Range Complex, August 2008. Department of the Navy, U.S. Fleet Forces Command, Norfolk,

Virginia.

U.S. Department of the Navy [Navy]. 2009b. Endangered Species Act section 7 consultation package for U.S. Fleet Forces activities conducted off the northeastern U.S. Department of the Navy, U.S. Fleet Forces Command, Norfolk, Virginia.

U.S. Department of the Navy [Navy]. 2010. Annual range complex report for the U.S. Navy's Virginia Capes, Cherry Point, and Jacksonville Range Complexes. 2009. U.S. Department of the Navy, Fleet Forces Command, Norfolk, Virginia.

U.S. Department of the Navy [Navy]. 2010. Marine species monitoring for the U.S. Navy's Virginia Capes, Cherry Point, and Jacksonville Range Complexes. U.S. Department of the Navy, Fleet Forces Command, Norfolk, Virginia.

U.S. Environmental Protection Agency [EPA]. 1998. Guidelines for ecological risk assessment. Federal Register 63(93); 26846-26924.

van Rij, N.G. 2007. Implicit and explicit capture of attention: what it takes to be noticed. A thesis submitted in partial fulfillment of the requirements for the Degree of Master of Arts in Psychology. University of Canterbury; Canterbury, United Kingdom.

Vanderlaan, A. S. M., C. T. Taggart, A. R. Serdynska, R. D. Kenney, and M. W. Brown. 2008. Reducing the risk of lethal encounters: vessels and right whales in the Bay of Fundy and on the Scotian shelf. Endangered Species Research 4:283-297.

Vladimirov, V.L. 2007. Scientific report for "Dalniy Vostok" and "Slava" for the 1969 season. Page 19. In: *Scientific reports of Soviet whaling expeditions in the North Pacific, 1955-1978*. *NOAA Technical Memorandum NMFS-AFSC-175*.

Edited by Y.V. Ivashchenko, P.J. Clapham and R.L. Brownell Jr. U.S. Department of Commerce, National Oceanic and Atmospheric Administration, National Marine Fisheries Service, Alaska Fisheries Science Center; Seattle, Washington.

Vladimirov, V.L. 2007. Scientific report from the factory ships "Slava" and "Dalniy Vostok" for the 1968 season. Page 18. In: *Scientific reports of Soviet whaling expeditions in the North Pacific, 1955-1978. NOAA Technical Memorandum NMFS-AFSC-175*. Edited by Y.V. Ivashchenko, P.J. Clapham and R.L. Brownell Jr. U.S. Department of Commerce, National Oceanic and Atmospheric Administration, National Marine Fisheries Service, Alaska Fisheries Science Center; Seattle, Washington.

von Ziegesar, O. 1984. A survey of the humpback whales in southeastern Prince William Sound, Alaska: 1980, 1981, and 1983. Report to the State of Alaska, Alaska Council on Science and Technology.

Wada, S. 1980. Japanese whaling and whale sighting in the North Pacific 1978 season. Reports of the International Whaling Commission 30:415-424.

Wade, P.R., and T. Gerrodette. 1993. Estimates of cetacean abundance and distribution in the Eastern Tropical Pacific. Reports of the International Whaling Commission 43:477-493.

Walsh, M. T., R. Y. Ewing, D. K. Odell, and G. D. Bossart. 2001. Mass strandings of cetaceans. Pages 83 - 96 in L. Dierauf, and F. M. D. Gulland, editors. Marine mammal medicine. CRC Press, Boca Raton, Florida.

Watkins W.A., W.E. Schevill. 1972. Sound source location by arrival-times on a non-rigid three-dimensional hydrophone array. Deep-Sea Research 19: 691-706. Watkins, W. A. 1977. Acoustic behavior of sperm whales. Oceanus. 2:50-58.

Watkins, W. A., K. E. Moore, D. Wartzok, and J. H. Johnson. 1981. Radio tracking of finback *(Balaenoptera physalu*s) and humpback *(Megaptera novaeanglia*e) whales in Prince William Sound, Alaska. Deep-Sea Research 28A(6):577-588.

Watkins, W. A., P. Tyack, K. E. Moore, and J. E. Bird. 1987. The 20-Hz signals of finback whales (*Balaenoptera physalus*). Journal of the Acoustical Society of America 82(6): 1901-1912.

Watkins, W.A. 1980. Acoustics and the behavior of sperm whales. Pages 283-290. In: R.G. Busnel and J.F. Fish (editors). Animal Sonar Systems. Plenum Press; New York, New York.

Watkins, W.A. 1981. Activities and underwater sounds of fin whales. Scientific Reports of the International Whaling Commission 33: 83-117.

Watkins, W.A. 1986. Whale reactions to human activities in Cape Cod waters. Marine Mammal Science 2(4): 251- 262.

Watkins, W.A. and W.E. Schevill. 1975. Sperm whales (*Physter catodon*) react to pingers. Deep-Sea Research 22: 123-129.

Watkins, W.A. and W.E. Schevill. 1977. Spatial distribution of *Physeter catodon* (sperm whales) underwater. Deep- Sea Research 24: 693-699.

Watkins, W.A. and Wartzok, D. 1985. Sensory biophysics of marine mammals. Marine Mammal Science 1(3): 219- 260.

Watkins, W.A., K.E. Moore, and P. Tyack. 1985. Codas shared by Caribbean sperm whales. In: Abstracts of the Sixth Biennial Conference on the Biology of Marine Mammals, November 1985; Vancouver, British Columbia.

Watkins, W.A., K.E. Moore, and P. Tyack. 1985. Sperm whale acoustic behaviors in the southeast Caribbean. Cetology 49:1-15.

Watkins, W.A., M.A. Dahr, K.M. Fristrup and T.J. Howald 1993. Sperm whales tagged with transponders and tracked underwater by sonar. Marine Mammal Science 9(1):55-67.

Watkins, W.A., P. Tyack, K.E. Moore, and J.E. Bird. 1987. The 20 Hz signals of finback whales (*Balaenoptera physalus*). Journal of the Acoustical Society of America 82(6): 1901-1912.

Weilgart, L. and H. Whitehead. 1997. Group-specific dialects and geographical variation in coda repertoire in South Pacific sperm whales. Behavioral Ecology and Sociobiology 40: 277-285.

Weilgart, L.S. 2007. The impacts of anthropogenic ocean noise on cetaceans and implications for management. Canadian Journal of Zoology 85:1091-1116.

Weilgart, L.S. and H. Whitehead. 1988. Distinctive vocalizations from mature male sperm whales (*Physeter macrocephalus*). Canadian Journal of Zoology 66:1931-1937.

Weinrich, M.T., H. Rosenbaum, C. Scott Baker, A.L. Blackmer and H. Whitehead. 2006. The Influence of maternal lineages on social affiliations among humpback whales (*Megaptera novaeangliae*) on their feeding grounds in the southern Gulf of Maine. Journal of Heredity 97(3): 226-234.

Weinrich, M.T., R.H. Lambertsen, C.R. Belt, M.R. Schilling, H.J. Iken and S.E. Syrjala. 1992. Behavioral reactions of humpback whales *Megaptera novaeangliae* to biopsy procedures. Fisheries Bulletin 90(3): 588-598.

Weinrich, M.T., R.H. Lambertsen, C.S. Baker, M.R. Schilling and C.R. Belt. 1991. Behavioral responses of humpback whales (*Megaptera novaeangliae*) in the southern Gulf of Maine to biopsy sampling. Reports of the International Whaling Commission (Special Issue 13): 91-97.

Weir, C. R., T. Ron, M. Morais, and A. D. C. Duarte. 2007. Nesting and at-sea distribution of marine turtles in Angola, West Africa, 2000-2006: occurrence, threats and conservation implications. Oryx **41**:224-231.

Wentsel, R. S. 1994. Risk assessment and environmental policy. Environmental Toxicology and Chemistry 13:1381. Whitehead, H. 1982. Population of humpback whales in the northwest Atlantic. Reports of the International Whaling Commission 32: 345-353.

Whitehead, H. 1987. Updated status of the humpback whale, *Megaptera novaeangliae*, in Canada. Canadian Field- Naturalist 101(2): 284-294.

Whitehead, H. 1993. The behavior of mature male sperm whales on the Galapagos Islands breeding grounds. Canadian Journal of Zoology 71(4): 689-699.

Whitehead, H. 1996. Babysitting, dive synchrony, and indications of alloparental care in sperm whales. Behavioral Ecology and Sociobiology 38: 237-244.

Whitehead, H. 1996. Variation in the feeding success of sperm whales: temporal scale, spatial scale, and relationship to migrations. The Journal of Animal Ecology 65(4): 429-438.

Whitehead, H. 1999. Variation in the visually observable behavior of groups of Galapagos sperm whales. Marine Mammal Science 15(4): 17.

Whitehead, H. 2002. Sperm whale (*Physeter macrocephalus*). Pages 1165 - 1172 in W.F. Perrin, B. Würsig, and J. G. M. Thewissen, editors. Encyclopedia of marine mammals. Academic Press, Inc., San Diego, California.

Whitehead, H. 2003, Sperm whales. Chicago, Illinois, University of Chicago Press.

Whitehead, H. and C. Glass. 1985. Orcas (killer whales) attack humpback whales. Journal of Mammalogy 66(1): 183-185.

Whitehead, H. and F. Nicklin. 1995. Sperm Whales. National geographic 188(5): 18.

Whitehead, H. and L. Rendell. 2004. Movements, habitat use and feeding success of cultural clans of South Pacific sperm whales. Journal of Animal Ecology 73(1): 190-196.

Whitehead, H. and L. Weilgart. 2000. The sperm whale: social females and roving males. Pages: 154-172. In: *Cetacean societies. Field studies of dolphins and whales*. Edited by J. Mann, R.C. Connor, P.L. Tyack and H. Whitehead. University of Chicago Press; Chicago, Illinois.

Whitehead, H. and L. Weilgart. 1991. Patterns of visually observable behavior and vocalizations in groups of female sperm whales. Behavior 118(Parts 3-4): 275-296.

Whitehead, H. and P.L. Hope. 1991. Sperm whalers off the Galapagos Islands and in the western North Pacific, 1830-1850: Ideal free whalers? Ethology and sociobiology 12(2): 147-162.

Whitehead, H. and T. Arnbom. 1987. Social organization of sperm whales off the Galapagos Islands, February-April 1985. Canadian Journal of Zoology 65(4): 913-919.

Whitehead, H., J. Christal and S. Dufault. 1997. Past and distant whaling and the rapid decline of sperm whales off the Galápagos Islands. Conservation Biology 11(6): 1387-1396.

Whitehead, H., J. Gordon, E. A. Mathews and K. R. Richard. 1990. Obtaining skin samples from living sperm whales. Marine Mammal Science 6(4):316-326.

Whitehead, H., L. Rendell and M. Marcoux. 2006. Coda vocalizations recorded in breeding areas are almost entirely produced by mature female sperm whales (*Physeter macrocephalus*). Canadian Journal of Zoology 84: 5.

Whitehead, H., M. Dillon, S. Dufault, L. Weilgart and J. Wright. 1998. Non-geographically based population structure of South Pacific sperm whales: dialects, fluke-markings and genetics. Journal of Animal Ecology 67(2): 253-262.

Whitehead, H., M. Dillon, S. Dufault, L. Weilgart and J. Wright. 1998. Non-geographically based population structure of South Pacific sperm whales: dialects, fluke-markings and genetics. Journal of Animal Ecology 67(2): 10.

Whitehead, H., S. Waters and T. Lyrholm. 1992. Population structure of female and immature sperm whales (*Physeter macrocephalus*) off the Galapagos Islands. Canadian Journal of Fisheries and Aquatic Science

49(1): 78-84.

Wiley, D.N., R.A. Asmutis, T.D. Pitchford and D.P. Gannon. 1995. Stranding and mortality of humpback whales, *Megaptera novaeangliae*, in the mid-Atlantic and southeast United States, 1985-1992. Fisheries Bulletin 93: 196-205.

Wilkinson, D. M. 1991. Program review of the Marine Mammal Stranding Network. Unpublished report prepared for the Assistant Administrator for Fisheries. U.S. Department of Commerce, National Oceanic and Atmospheric Administration, National Marine Fisheries Service, Silver Spring, Maryland.

Wingfield, J. C., K. M. O'Reilly, and L. B. Astheimer. 1995. Modulation of the adrenocortical responses to acute stress in Arctic birds: A possible ecological basis. American Zoologist 35:10.

Winn, H.E, P.J. Perkins, L. Winn. 1970. Sounds and behavior of the northern bottlenosed whale. Pages 53-59. In: Proceedings of the 7th Annual Conference on the Biology, Sonar and Diving of Mammals. Stanford Research Institute; Menlo Park, California.

Winn, H.E., C.A. Price, and P.W. Sorensen. 1986. The distributional biology of the right whale (*Eubalaena glacialis*) in the western North Atlantic. Reports of the International Whaling Commission Special Issue No. 10:129- 138.

Witzell, W.N. 1999. Distribution and relative abundance of sea turtles caught incidentally by the U.S. pelagic longline fleet in the western North Atlantic Ocean, 1992-1995. Fishery Bulletin 97:200-211.

Wood, W.E. and S.M. Yezerinac. 2006. Song sparrow (*Melospiza melodus*) song varies with urban noise. The Auk 123:650-659.

Yeung, C. 1999. Estimates of marine mammal and marine turtle bycatch by the U.S. Atlantic pelagic longline fleet in 1998. NOAA Technical Memorandum NMFS-SEFSC-430. U.S. Department of Commerce, National Oceanic and Atmospheric Administration, National Marine Fisheries Service, Southeast Fisheries Science Center; Miami, Florida.

Yochem, P. K. and S. Leatherwood. 1985. Blue whale *Balaenoptera musculus* (Linnaeus, 1758). In: S.H Ridgway and R. Harrison (editors) Handbook of marine mammals. Volume 3. The sirenians and baleen whales. Academic Press, Inc.; London, United Kingdom.

Young, G.A. 1973. Guide-lines for evaluating the environmental effects of underwater explosion tests. U.S. Department of the Navy, Naval Ordnance Laboratory; Silver Spring, Maryland.